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Monograph of the Isoetaceae

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MONOGRAPH OF THE ISOETACEAE[1]

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History

The name *Isoetes* was first mentioned by Linnaeus in 1751 (Skanska Resa, 417, fig. 1), although the common European species of the group had been previously known for many years and variously recorded under different names. In 1753 Linnaeus (Species Plantarum 2: 1100) definitely established the genus *Isoetes,* as follows:

> "*lacustris.* ISOETES. *It. Scan.* 417. *t.* 419. *Nov. gen.* 1109. Marsilea foliis subulatis semicylindricis articulatis. *Fl. suec.* 996. [Stockholm, 1745].
> Calamaria folio longiore & graciliore. *Dill. musc.* 541. *t.* 80. *f.* 2. [Oxford, 1741].
> Subularia lacustris f. Calamistrum herba aquatica alpina. *Raj. angl.* 1. *p.* 210. *t.* 210. [London, 1677].
> *Habitat in* Europae *frigidae fundo lacuum.*"

In the following year Linnaeus (Genera Plantarum, 486. 1754) characterized the genus, relating the structures to those of seed plants. The male flowers were described as solitary within a base of inner leaves, with no corolla, but with a calyx of cordate scales, acute and, sessile, and with stamens having subrotund, unilocular anthers, but no filaments. The female flowers were reported as solitary, within a base of outer leaves of the same plant, with the calyx and corolla situation as in the male. The pistil was described as having an ovate embryo within a leaf, but the style and stigma were supposed to be hidden. The fruit was considered to be a capsule, subovate and bilocular, concealed in the base of the leaf, and the seeds to be numerous and globose. In an earlier account (Skanska Resa, 417. fig. 1. 1751), Linnaeus expressed jubilation over finding flowers, whereas Dillenius had seen only fruits.

[1]Special investigation carried on mainly at the Missouri Botanical Garden.

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Crude as is the description of Linnaeus, it surpassed the earlier accounts. Ray, who provided the earliest account, credited D. Lloyd with finding the material in an alpine lake, and remarked that "of this plant, one sees nought but leaves and roots, and knows not from what source it comes directly."

Dillenius developed a little greater detail in regard to the structure. He described two plants, similar in their fleshy tubers, but differing in the shorter, coarser, incurved leaves of the one, and the finer, longer, erect leaves of the other. The latter, considered synonymous with *I. lacustris* L., is described as having "a root harder than a leek, less tuberous, less thick," but otherwise having the same texture of leaf, color, seeds, etc. In the description of the short-leaved form, the channels in the leaf and the transverse septa are brought out as they are in the diagrams of the fine-leaved plants. The plants are reported as growing "in great abundance in very long, deep ponds near Llanberry" and in mountain lakes.

Scarcely more enlightening is the account of the next species of *Isoetes* to be recorded. In 1781, *I. coromandelina,* similar to *I. lacustris* L., but larger, was reported by Linnaeus fil. as growing in wet places, submerged in the rainy season, in Coromandel. Attention in the description is chiefly drawn to the filiform, erect, glabrous character of the leaves and the broadened membranaceous leaf-bases which form the bulbous portion of the plant.

The first detailed account of the development of *Isoetes* occurs in connection with the description of a third species, *I. setacea,* by Delile[1] in 1827. He carefully observed the life-history through the seasons, and as a result laid a better morphological basis than his predecessors. A comparison is made with *Lycopodium* but the author decides that *Isoetes* resembles the lily or *Juncus* more in its embryo characters. However, the genus is finally placed between *Marsilea* and *Lycopodium,* with interpretations of all structures made on the basis of seed-plants.

The following year H. G. L. Reichenbach published the first account in which the family name for *Isoetes* is used, here as *Isoeteae.* This, or similar forms, as *Isoetineae,* is used by all the subsequent workers cited up to the paper of Underwood, where the modern *Isoetaceae* is used for the first time. There is a good deal of confusion in the references given by some of

[1]Delile. A. R. Examen de la vegetation de l' Isoetes setacea et exposition de ses caractères. Mus. Paris Mem. **14**: 110–119. *pl. 6–7.* 1827.

the earlier authors, as, for example, Schnizlein, who credits Bartling as the originator of the family name in the text and Richard in the legend on the plate illustrating his paper.

References occur twice which suggest that Claude Richard was responsible for the idea of a separate family containing the *Isoetes* species. Delile himself in 1827 places the genus between *Lycopodium* and *Marsilea,* but says that Richard believes it a family distinct from *Lycopodium* and other ferns. Again, in 1844, we have the statement of Bory that Claude Richard believes that *Isoetes* ought to be considered as a separate family from other ferns. It has been impossible to find any account published by Richard himself in regard to this point.

Within a short interval after Delile's work on *I. setacea* Bosc, much interest was stimulated in the genus through the work of two investigators, A. Braun and Durieu de Maisonneuve. The former developed not only systematic, but much morphological, knowledge in regard to various species. The latter was chiefly instrumental in augmenting systematic information, especially in regard to Algerian species.

In 1867, Milde[1] brought together forms that occur within a relatively much larger territory than had been previously considered. An idea may be obtained of the various contributions, especially of Braun and Durieu, from the fact that by this time the number of species within the range of Milde's work is 15.

A synopsis of the species of *Isoetes* was published within a little over a decade by Baker[2], who later incorporated the same manuscript with little additional material in his 'Fern Allies'. In this synopsis, 46 species are brought together by the author whose primary divisions are on the basis of geography.

Following Baker's work, Motelay and Vendryès[3] monographed the genus, including 47 species. The work is enhanced by the illustrations which include those of many spore forms. Not a few of the forms considered in Baker's synopsis and in the monograph by Motelay and Vendryès were due to the activity of Engelmann.[4]

[1]Milde, J. Filices Europae et Atlanticis, Asiao minoris et Siberiae, 274–290. 1867.

[2]Baker, J. G. A synopsis of the species of Isoetes. Jour. Bot. **18**: 65–70, 105–110. 1880, and Fern Allies, 123–134. 1887.

[3]Motelay, L. et Vendryès. Monographie des Isoëteae. Soc. Linn. de Bordeaux, Actes **36**: 309–405. *pl. 8–17.* 1883.

[4]Engelmann, G. The genus Isoëtes in North America. St. Louis Acad. Sci., Trans. **4**: 358–389.1882.

In 1882, in a systematic treatment, he considered the North American forms to the number of 15 species with their varieties. The contribution is of exceptional value as an account of the genus and includes an excellent treatment of the history of the genus in this country.

Almost simultaneously with this work appeared Underwood's[1] publication in which he first used the modern form of family termination in *Isoetaceae*. A lucid account of 14 forms in North America is supplemented with good generalizations on the distribution of forms.

Within more recent years, there has been no outstanding addition to our systematic knowledge of the family through the activity of European investigators. In America, there has been a material increase in information, especially concerning the representatives on the eastern border, through the work of Dodge[2] and Eaton.[3] These authors, as is true of most of their predecessors, published less comprehensive studies in various journals.

In a less technical consideration of the family, Clute[4] has recently recognized 21 species in the United States. This represents the latest account of the genus as a whole in America. There have, however, been treatments over more restricted ranges in various manuals and floras. The more important of these are cited in connection with the systematic treatment of the family, and therefore require no further consideration here.

Local Names and Economic Uses

The first popular name recorded for *Isoetes* is that given by Dillenius in 1741, where "quillwort" and "Merllyn's Grass" are cited. That the former name has survived is well known to us in America, and Clute[5] is authority for the statement that *Isoetes lacustris* is still called Merlin's grass in northern Europe.

Linnaeus in 'Skanska Resa' reports that the natives refer to *Isoetes* as "Brachsen grass." Ascherson and Graebner (Syn. Mitteleur. Fl. 1: 163. 1896-98) give the following: "Brachsenkraut: dän: Brasenurt: poln: Poryblin. böhm. Sédlatka."

[1]Underwood, L. M. Our Native Ferns and Fern Allies, 121. 1882.
[2]Dodge, R. Ferns and Fern Allies of New England. 1896.
[3]Eaton, A. A. The Genus Isoetes in New England. Fernwort Papers. 1900.
[4]Clute, W. N. The Fern Allies, 209–254. 1905.
[5]Clute, W. N. *loc. cit.* p. 224.

The technical name for the genus seems to be in common use. By derivation, it indicates the evergreen character of at least some of the species "equal at all seasons of the year" or throughout the year, from ἴσος, equal, and ἔτος, year. Some forms are, however, false to the name in that no leaves, sterile or otherwise, seem to survive the winter or dry season. The perennial character of the corm is not to be doubted in such plants though the leaves do disappear.

In the older accounts, it is of interest that an economic relation was usually mentioned. So Ray (1696) says that the plant "gives out a melancholy fluid, used in affections of the spleen and liver. It is accredited somehow with sharing the habit of the plants with which it grows." Dillenius, on the other hand, cites as its use that the plant is eaten by fish.

That birds are not disinterested in the food use of *Isoetes* is evidenced by the story of Durieu, who first saw *I. histrix* bulbs under rather unusual circumstances.[1] The peculiar organs were found in the stomach of a bird which was shot down by a member of his party. The real nature of the plant structures was only recognized in subsequent field work when similar bulbs were discovered growing on the hillsides of Algeria. That a terrestrial form resembling this Algerian plant, *I. Duriaei,* is eagerly devoured by pigs, is also quoted from the statements of Bory de Saint-Vincent.

In the eastern United States, one observer says that ducks are fond of the bulbs or sporangia masses at the base of the plant and will tweak them off, allowing the leaves to float. Clute says of *I. Braunii* Dur. that the crisp bulbs are favorite morsels with muskrats, and that cattle are said to feed upon the leaves of any species available.

The corms are said to have been eaten occasionally in Europe by human beings, though the taste is variously described as earthy and unpalatable (Clute) or acid and bad-tasting (Delile). Undoubtedly the presence of starch and oil give the spores and corms food value, whether they be palatable or not. The distribution hardly seems extensive enough to make consideration of development of a taste for them worthy of attention. The plants probably are of greatest economic use at present as a source of food for the lower animals mentioned.

[1]Bory de Saint-Vincent, Sur les Isoëtes et les espèces nouvelles de cette famille decouvertes en Algerie. Compt. Rend. Acad. Paris **18**: 1167. 1844.

General Morphology

The genus limits of *Isoetes* are very sharp and clear, so that there is no difficulty in recognizing a member within it. However, sections within the genus prove more difficult of discovery and definition. In the past, much emphasis has been laid by systematic workers in this field on the relations to water. Engelmann used the subdivisions "submersed, amphibious, and terrestrial" as his primary subdivisions. Motelay and Vendryès used two main headings, thus:

I. Aquaticae
- Submersae
- Palustres
- Amphibiae

II. Terrestres

It has seemed that the ecological relations might not be adequate as bases for primary divisions of the genus. The attempt has therefore been made to utilize more constant features of a morphological character. It seemed that the spore characters, related as they are to fruiting rather than to vegetative stages, might prove more consistent. It has been found that the megaspores, especially, run fairly constant in size and markings. In conjunction with these spore characters, it is necessary for safety in classification to take into consideration other features, such as the velum, which proves fairly dependable as a character, the lobing of the plant corm, usually a reliable feature, and other less constant characters like the ligule and the presence and number of peripheral strands of supporting tissue in the leaf. These features are considered in greater detail in the subdivision which follows, i. e., morphology.

In the genus the habit of the body is definitely characteristic and easily recognized in perfect specimens. The stem portion is unusually compact, both vertically and horizontally, and gives rise to a group of rush-like leaves in crowded spiral formation, and to many dichotomously-branched roots.

Stripped of its leaves and roots, the perennial stem is readily seen to have two or three more or less deep furrows, which result in producing a two- or three-lobed body. The number of lobes so produced is characteristic of the species concerned, save in the rare cases where three lobes may be found in a usually bilobed form or four in a trilobed. The roots appear chiefly in the fur-

rows, somewhat obscuring the real form of the stem in many cases.

The upper portion of the stem or corm is flattish or concave; in growth, the central lowest part gives rise to the newest leaves, while the successively older ones are pushed out to the periphery by the newer growth. There is no apical cell responsible for stem growth, according to Farmer ('90), although according to the evidence seen by Scott and Hill ('00) there may be one.

Anatomically, the compact stem has proved an interesting problem. The vascular cells are centrally located in a single group, which has been interpreted either merely as a union of the leaf-traces (Hegelmaier, '72) or as a small distinct stem stele plus the leaf-traces (Scott and Hill, '00).

Although the xylem character of the tracheids in this central region seems clear, there has been much discussion as to the significance of the zone immediately about it, the so-called "prismatic layer." According to Russow ('72) and Scott and Hill ('00) this undoubtedly contains distinct phloem elements. According to Farmer ('90), Wilson-Smith ('00), and Stokey ('09), the phloem interpretation is invalid, because of the inability to identify sieve structures here. The last-named worker sees only xylem cells as representatives of conducting tissues in this region.

A meristematic zone adds new tissue to the prismatic layer and to the outer parenchyma region. The latter, cortex in nature and position, usually dies at the margin, and in time is sloughed off, although the accumulation of dead cells may be appreciable before being worn off. This is especially true in terrestrial forms where the leaf bases are persistent and the dead cortex remains in place over successive seasons. More frequently, however, the wearing away tends to balance in part the increase in diameter, so that even very old stems are not excessive in size.

The roots are interesting in that they branch dichotomously. In anatomy, they are peculiar in being collateral endarch. The vascular bundle upon emergence from the central stele is surrounded by parenchyma which is replaced by a small group of phloem cells on the side away from the axis of the stem (Stokey, '09).

In the early growth of the sporophyte and before sporophyll production in each growing season, sterile leaves are usually produced. These are similar to the fertile leaves or sporophylls

which appear later except for the absence of the sporangium.

The leaves consist of two regions, a long narrow extension widening into a sheathing base, the margins of which are membranaceous in character. The lateral extension of the base and the longitudinal extension of the transparent edges may serve in some degree as diagnostic characters, though there is variation according to the size of the plant, position of the leaf, and especially the depth of the corm in the soil.

On the upper or inner face, each leaf bears a delicate little extension of tissue, free end uppermost, lying parallel to the leaf surface. This ligule in face view appears most often triangular, sometimes much elongated, sometimes subulate or rounded. To some extent, the form and size of the ligule may prove of value in diagnosis, though not constant enough to be of determining caliber. Especially in older leaves, it may be imperfect through tearing of the delicate tissue. The ligule was called the "calyx" by Linnaeus, and "processus glandulae" by Cesati and DeNotaris ('58). The former interpretation may be understood in view of the attempt to homologize structures in *Isoetes* with those in flowering plants. The latter term is clear when one sees the swollen imbedded portion of the ligule, called the "glossopodium" by A. Braun ('64). This, in section, is sharply distinguishable from the adjacent tissues of the leaf, though intimately grown to them, and might readily be compared to a glandular structure.

Wilson-Smith further terms the layer of large glandular cells about the glossopodium and next the leaf tissues proper the "sheath" and distinguishes between the dead marginal and apical cells, and the living central region of the tongue-like extension of the ligule.

The origin of the ligule has been shown to be a single superficial cell (Hofmeister, '62, and Wilson-Smith, '00) of the leaf, which develops very rapidly to form a short row of cells, soon becoming a plate, except in the basal portion which, as indicated above, becomes massive.

The insertion of the ligule is sometimes marked by a fold of tissue immediately below the base, to which Braun applied the name "labium". This is apt to be fairly consistent in the degree of development within the species, but is so small a character that it is difficult to use it in a diagnostic fashion.

In early stages of leaf development, the ligule is longer than the leaf, which is originally a low rudiment, soon developing into an elongated structure with a broader base. The latter develops more rapidly at first both in size and differentiation; later the distal portion exhibits greater growth, resulting in the elongated part above the ligule. In this region, there occur four long air-channels, intersected at intervals by transverse partitions. The cavities are produced while the upper part of the leaf is still meristematic. Groups of cells lose their contents, the cells break apart through solution of the pectins of the middle lamella, a process followed by disintegration of cells while intervening patches fail to change and so form the septa. The continued growth of the living cells at the periphery brings about increase in length and width of the cavities between these diaphragms.

At the center of the leaf in the tissue between the channels, the single collateral vascular bundle is located. Peripherally, in the layers of green tissue, may occur strands of supporting or mechanical tissue, which have commonly been called "peripheral bast." Since there seems to be no reason for assigning a conducting function to the thick-walled cells in these groups, the term peripheral strands is here substituted for bast. By far the most common distribution of these strands is that in which there is one at each side angle of the adaxial face and one each at the adaxial and abaxial ends of the middle partition. When six groups are present, the other two are at the ends of the cross-partition. Any accessory strands produced are not usually so well developed as these six.

In leaves which are fertile, the sporangia occur singly at the base, on the inner face of the leaf. At maturity, each sporangium appears to be fitted into an elongated or round cavity, termed the "fovea" by Braun. From the margins except at the base there may be a fine, one-celled layer of tissue, the velum, extending over the sporangium to a greater or less degree. Within limits, the degree of development of this velum may be useful as a diagnostic feature. Some forms characteristically show no velum formation, as *Isoetes Malinverniana;* in *I. Engelmanni,* the velum is usually narrow but evident; in *I. Orcuttii,* it is complete, covering the sporangium all the way to the base. In the form *I. Braunii,* the American ally of *I. echinospora* Dur. it varies from 1/3 to 2/3, or occasionally even more extended.

Where the sporangium wall is exposed, it, as well as the adjacent epidermal tissue of the leaf base, may show wall thickening in groups of cells, resulting in a brown-spotted effect under magnification. When the patches of brown sclerenchymatous cells are very numerous, the brown coloring is readily noted; an extreme case is found in *I. melanopoda* Gay & Dur., where the specific name is derived from the deep coloring of the bases of the leaves.

The sporangia are of two sorts, occurring in the same plant, though in some cases at different seasons. A striking example of probable difference in time is found in the East Indian form. The description of *I. coromandelina* L. fil. and *I. brachyglossa* A. Br. both left the condition of the microspores and microsporangia in doubt because of the failure to obtain microsporangiate material. In a collection sent from India through the courtesy of Dr. W. S. Dudgeon, all the sporangia appeared to be megasporangiate. Yet with diligent search about the bases, among old megaspores, microspores, probably from the previous season, were found.

The sporangia of the two kinds have been found to originate and pass through their early stages in similar fashion (Bower, '08, Wilson-Smith, '00). It is only in later development, and especially at maturity, that the heterosporous nature becomes striking. The sporangium initial is a transverse row of superficial cells, which by periclinal divisions, give rise to wall layers and to a sporogenous mass. The velum may be derived from a part or the whole of the upper tier of cells arising from the division of the initial cells (Wilson-Smith, '00). According to the results of Scott and Hill, the velum arises from the tissue between the ligule and the sporangium initial. The growth here in the "sella," a term given by A. Braun, first gives the labium by upward growth, and then the velum by downward extension.

Bands of cells in the sporogenous region become sterile, forming the trabeculae, eventually more or less plate-like cross extensions into the spore mass, bordered by a tapetal layer (Wilson-Smith). The trabeculae are unusually large and distinct in the megasporangia, in which some of the potentially sporogenous cells develop at the expense of others. The large functional ones produce tetrads of megaspores, whereas in the microsporangia, all the sporogenous mass, except the trabecular strips, produces microspores.

The group of microspores from a mother cell may show bilateral or tetrahedral arrangement. In either event, the freeing of the spores soon allows the loss of the sharpness of the original form, so that the microspore is more or less rounded at the two side angles, though with a sharper angle on the third side, parallel to the long axis. Usually the long diameter of the microspores will fall between 20 and 40 μ, with the width or thickness less than 25 μ. In some forms, there are markings of the exospore, resulting in papillose or spinulose effects. More rarely, there may be the development of a wing extension or crest, especially on the side opposite the sharp angle. There is little variation in coloring in the microspores, which are generally ashy, fawn, or cinnamon-brown. As diagnostic features, the microspore size, primarily, and markings and coloring, secondarily, may be used to advantage.

The study of the megaspores has many advantages over that of microspores. Their greater size, due to the functioning of fewer cells in the sporangium at the expense of other potentially sporogenous cells, makes for facility in handling. The size varies in the species between 250 and 900 μ in general, with a much smaller range in the individual species. The coloring of the megaspores in most cases is white or gray-white but in cases of exceptions, as the black in *I. melanospora* Engelm., the color is a useful diagnostic character. Most important are the markings or sculpturing on the surface of the siliceous exospore. The spores, formed in tetrahedral groups, retain the impression of their three neighbors on three faces, which are separated by rounded or sharp ridges which converge at the apex (sometimes called commissural ridges). The fourth face of each spore, originally the free surface in the tetrad, is hemispherical or but slightly flattened, and is separated from the three more nearly plane faces by the ridge called the "equator."

The sculpturing, consisting of spines, of small tubercles or warts, or of reticulate markings, may be similar on all faces, or may differ from the other three on the fourth or basal side. These characters within the species seem as conservative features as occur in *Isoetes* and therefore of great value diagnostically.

The sporangia in *Isoetes* lack a definite device for dehiscence, and hence both types of spores are released only upon decay of the sporangium walls. As a result, there is an accumulation of

the spores about the bases of the still active leaves, from which material for study of the gametophyte stages may be drawn.

The microspore upon germination gives rise to a small lenticular cell at one end, which has been called the prothallial cell. The remaining cell, the antheridium initial, divides in such fashion that a single wall-layer is formed, investing a central region of four cells, each one of which produces a large multiciliate, spirally coiled sperm (Belajeff, '85).

The megaspores, well filled with storage material of starch and oil, are reported by Campbell ('91) as undergoing free nuclear division to the number of 30–50 nuclei, when division walls begin to appear at the apical end, later along the margin of the spore, and eventually in the central portion. There is some increase in size with development, as a rule, so that there is cracking along the three ridges converging at the apex. It is in this region that the archegonia develop, so that three lines of these up to the number of thirty can be observed, if fertilization is prevented. According to Campbell, the archegonium initial divides transversely, giving rise to the cover cell (later producing four tiers of neck cells) and the inner cell (later dividing into the neck canal and the central cell). The neck canal nucleus divides, but according to Campbell, no wall is produced and it remains a short wide cell. In other species, a longitudinal wall has been reported by Miss Lyon and Arnoldi. The central cell divides to produce an egg and a ventral canal cell quite as broad as the egg.

When mature, the archegonium shows the usual canal to the egg, due to disintegration of the canal cells, which allows the entrance of sperms and the subsequent fertilization of the egg. In the development of the embryo, the first stage (Campbell) is transverse division into two cells, followed by a quadrant stage in the most regular cases. The two lower quadrants are reported as giving rise to the foot, one of the upper to a leaf and one to a root. Later, a stem tip develops between the leaf base and the root, in such manner that its origin may be from either. Very early in the development of the leaf rudiment, the ligule cell begins its activity. Division of cells and elongation is rapid in all regions, so that the stages pass quickly. The embryo sporophyte soon projects beyond the gametophyte, a second leaf is formed and a second root. Meanwhile, there is tissue differentiation; the vascular elements of the leaf, stem, and root are

distinct, and the air-channels (only two in the first leaves) are produced.

After development of sterile leaves for a few seasons, the sporophyte begins to produce sporangia, as previously noted.

Apogamy has been reported by only one worker, Goebel ('97), who found examples in *I. lacustris* L. and *I. echinospora* Dur. where the tiny leaf-producing shoots eventually giving rise to roots replaced sporangia in position. These plantlets became independent by the decay of the old leaf tissue.

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Ecological Relations of the Genus Isoetes

The genus *Isoetes* presents interesting ecological and geographical relations. The species prove very diverse in habitat, ranging from lacustrine forms submerged in five or more feet of water, to those strikingly xerophytic, exposed on dry hillsides. Structural characters appear unusually constant, save in minor points. Plants are perennial, and in some cases seem able to withstand desiccation over long intervals, appearing after one or

more dry seasons. Still others grow where alternately submerged and exposed during each growing season.

Ecologically, therefore, it is convenient to subdivide the group into (1) submersed, (2) amphibious, and (3) terrestrial forms, though this does not represent systematic relations.

The geographic range of the individual species is usually limited, but representatives of the genus are found in practically all explored countries. In Europe, France leads with five species; in Africa, Algeria with four species and one variety. In North America, Massachusetts with five species has probably more recorded stations than any other state. California has six species recorded, one of which is truly terrestrial. At present, it is difficult to determine centers of distribution, but the accumulation of more data should help in ascertaining relations.

By means of a tabular survey of some North American species, one can gain an idea of the range of species relations in the matter of habitat, plant associates, structural diversity, etc. In every subdivision, one can find examples from different regions of the world. North American forms, particularly those of a somewhat extended range, are chosen simply because of more available data.

It may be noticed that all submersed or amphibious forms are related to fresh water. The original account of a salt-water relation for *I. maritima* has since been corrected. The terrestrial forms, *I. melanopoda* and *I. Butleri*, are found in so-called "alkali flats" where the content of magnesium and sodium sulphates is high. These flats are very level, and so become very wet in the spring but are very dry in summer, for the clay or hard pan is covered by too thin a soil layer to hold moisture (E. Hall).

In other regards there is much diversity in habitat relations. Most of the submersed forms are related to lakes or ponds, varying from a few inches to six or more feet in depth. Of the amphibious forms, some are riparian, notably *I. riparia* and *I. saccharata*, but most are found in pools or ponds, where they form a marginal zone, thus becoming exposed in the usual seasonal lowering of the water level. These ponds or lakes may be in meadows, woodland, or as in the case of *I. melanospora*, may be merely low depressions in granite rock, which contain a few inches of soil and which in summer retain no water, leaving the plants to be parched and dried by full exposure to the sun.

Name	Habitat	Associates.	Per str.	Stom.	Velum	Season
		SUBMERSED SPECIES				
I. Braunii Dur.	Ponds, slow streams, lakes; gravel, soft mud, firm sandy soil with silt	*Eriocaulon, Lobelia, Sparganium, Scirpus, Eleocharis*	0	Few	½	June-Sept.
I. Tuckermani A. Br.	Gravelly lake bottoms; gregarious		0	0	Narrow	Aug.-Oct.
I. Bolanderi Engelm.	Lakes, ponds; mud covering gravel; gregarious	*Menyanthes*	0	Few	Narrow	June-Sept.
I. occidentalis Hend.	"Granitic sand"		0	0	Narrow	Aug.-Sept.
		AMPHIBIOUS SPECIES				
I. riparia Engelm.	Gravelly or muddy river banks	*Limosella, Sagittaria, Elatine, Micranthemum*	0	Present	Partial	Aug.-Sept.
I. saccharata Engelm.	Gravelly shores; tidal mud; sand among rocks	*Sagittaria, Eriocaulon, Tillaea, Micranthemum*	0	Present	⅓+	Aug.-Sept.
I. Engelmanni A. Br.	"Ponds and ditches; immersed in mud"	*Polygonum, Lycopus, Carex, Parnassia*	4	Abundant	Narrow	Summer
I. flaccida Shuttlew.	Lakes or swamps; muddy bottoms, "limestone lakelet"	*Nasturtium, Carex*	4	Numerous	Complete	June Aug.
I. cubana Engelm.	"In rivulet"		6	Rare	Narrow	?
I. Tuerckheimii Brause	"Rock fissures in rivulet"		0	At tip	Narrow	Aug.

I. Oreattii Eaton	Desiccating pools, clay	Grasses, *Calochortus*	0 (or 2)	Present	Complete	Feb.-Apr.
I. Pringlei Underw.	Springy places	Grasses	6+6–10 accessory	Numerous	Narrow	Nov.
I. mexicana Underw.	Borders of shallow ponds, to almost terrestrial; sandy plains		4	Numerous	Very narrow	Aug.-Oct.
I. Nuttallii A. Br.	Damp flats	Prairie vegetation	3 (or 2)	Numerous	Complete	May-June
I. melanopoda Gay & Dur.	Amphibious to terrestrial; wet prairies, limestone ledges; wet sands	*Nasturtium, Penthorum, Ludvigia, Alisma, Juncus*	4 (or 6) (+accessory)	Numerous	Partial	May-July
I. melanospora Engelm.	"Amphibious. In few inches of soil in naked granite rock."	*Amphianthus pusillus*	0	Present	Complete	May-June

Such plants as this might be considered as grading readily into the more distinctly terrestrial forms. Of these transitional forms, some start growth in very moist habitats, fruit as the season progresses, and die down except for the corm, during the very dry intervals of late July and August. Such plants as these could not have come into consideration when the name "Isoetes, equal at all seasons" was applied. In our country, *I. Orcuttii* of southern California appears "in level pastured meadowland, growing scattered in grassy sod, especially in low places, but never in places where water stands or has stood. The leaves so nearly resemble surrrounding grass in size and color that the plant can scarcely be found except by lifting sod and tearing it apart." In some ways it seems comparable to the Algerian forms, *I. histrix* and *I. Duriaei,* which grow in exposed places, the latter with xerophytic grasses in crevices on granitic mountain slopes.

Plant Associates.—Data in regard to the plants occurring with *Isoetes* are not available in many cases. The table shows what has come to notice in this regard, in some American species. Frequently it would seem that *Isoetes* has few competitors where it succeeds in holding its own. On the the other hand, it may be so thoroughly mixed with grasses, sedges, and other forms of a like habit, that it is easily overlooked.

Physiological and Structural Relations.—In the matter of structural characters, there is an unusual uniformity throughout the group, regardless of environment. All display a corm of two or three lobes, in which reserve material is deposited. In some cases, the corm endures drought for one or more seasons and, with return of moisture, again becomes active. The corm rarely branches, and hence there is no vegetative spread by this method. There is great diversity in number and size of leaves; and though this appears to have no invariable relation to the habitat, smaller forms frequently occur in the terrestrial group. There is a general plan of structure in the leaves which includes four longitudinal air spaces, separated by septa, and surrounded by a peripheral wall of green tissue. There is a tendency for greater development of the air-spaces, with relatively fewer layers (as low as two) of green tissue and narrower septa in the submersed forms. Species in dry situations show less surface development. The leaves are usually narrower with small lacunae, walled by

several layers of compact tissue and separated by as many as five to seven layers in the partitions.

In terrestrial forms, the bases of the leaves often prove persistent. Sometimes they remain as simple brown papery scales, but in their most striking forms they become horny, with extended spines, marginal and central, as in *I. histrix.*

The leaf shows variation in two other directions, in the distribution of groups of mechanical cells in the peripheral region and in presence of stomata. The former may be entirely lacking, as usually occurs in submersed forms, and sometimes in amphibious. With exposure to air, there is development of these groups of supporting cells, often to the number of four, sometimes six, chief aggregations, which are accompanied by smaller ones on occasion. The degree of development of such accessory groups varies greatly. Frequently the upper, more exposed region shows more of these groups of cells.

In the case of stomata, there is no uniformity within the submersed group. *Isoetes echinospora* and a close ally, *I. Braunii* of America, both submersed, show striking dissimilarity in this regard. The former has no stomata, the latter always some. Other species may show even more. In the amphibious and terrestrial forms, it is obvious that there will always be more or less development in the regions exposed to air.

A third leaf feature, the velum, which covers the basal sporangium, has attracted more or less attention. It is included here for that reason, rather than because of any definite correlation with ecological features. The range from very narrow to complete veils seems to be run in each group.

Very little attention has been paid to root systems, which are in all cases fibrous, as a result of dichotomous branching.

Seasonal Relations.—All species of *Isoetes* appear perennial, with a longer or shorter growing season. Submersed forms are reputed to be green during a longer period, as a rule, and usually fruit late, as August to October. A few amphibious forms fruit in the spring, and then die down during the summer, sometimes to become green again in fine fall weather. Engelmann traced through the seasons the activity of *Isoetes Engelmanni*, a vigorous amphibious form, which continues active throughout the summer and fall season, producing spores for a relatively long period. *I. Malinverniana* of the aqueducts of Piedmont, Italy,

is reported as fruiting throughout the summer. Most forms are more restricted, as, for instance, *I. melanopoda* in May and early June, or *I. riparia* in August and September.

After spore production, there is a more or less rapid development of the alternating generation, as shown by Engelmann in his cultures. The sporeling stage then appears in a short interval after spore production, a point demonstrated as early as 1828 by Delile in his careful observations on *Isoetes setacea*. Sporelings produce a small group of leaves which are sterile. Fruiting structures appear only in the second or subsequent seasons.

Geographic Distribution.—It is the experience of collectors that the distribution of *Isoetes* species is remarkably restricted, though there are representatives in most parts of the world.

In North America there is a striking exception to this in *I. Braunii* Dur., a form found both on the east and west coasts, and in much of the territory between these. Maine and Massachusetts are perhaps richest in the number of stations reported, but the form is common in eastern Canada, in the northeastern United States, and is reported less frequently in Ohio, Indiana, Michigan, Wisconsin, and Minnesota. There then appears a considerable gap in the continuity, with the western representatives appearing only as far as Utah, and then westward up the coast.

I. macrospora Dur. and *I. Engelmanni* A. Br. possibly represent the forms next most widely distributed. The former is northern, like *I. Braunii,* and is found in eastern Canada, and the northern United States as far west as Minnesota. *I. Engelmanni* is of slightly more southerly occurrence, and is found from New England, west to the Mississippi Valley, with Engelmann's own station at St. Louis as the farthest west.

More restricted in character are the following species of the eastern border: *I. Tuckermani, I. riparia, I. saccharata, I. Eatoni,* and *I. foveolata.* Farther south, in Georgia and Florida, occur *I. flaccida* and its variety *alata,* while *I. melanospora* is endemic in one station, Georgia, and *I. lithophila* in Texas.

In the central states, besides *I. Engelmanni,* the form *I. melanopoda* Gay & Dur. proves of rather extended range in Illinois, Missouri, Nebraska, Iowa, Oklahoma, and Texas. Its companion form, *I. Butleri,* occurs in the western part of this range in even drier localities.

The west coast of the continent boasts of eight distinctive species and three varieties. Of these, four species are especially northern in character, occurring in Washington or farther north, i. e., *I. Piperi, I. Flettii, I. occidentalis, I. truncata.* Four are either more extended to the south, as *I. Nuttallii, I. Howellii,* and *I. Bolanderi,* or restricted to southern California, as *I. Orcuttii.*

This last species even extends into Lower California, and therefore, with *I. mexicana* and *I. Pringlei,* represents the genus in Mexico.

The West Indies yield two endemic forms, *I. cubana* (Cuba) and *I. Tuerckheimii* (Haiti).

Of the South American forms, three are reported for Brazil, *I. amazonica, I. Gardneriana,* and *I. Martii.* Three others, less known in collections, occur in more remote stations, *I. Lechleri* (Argentine), *I. triquetra* (Peru), and *I. Savatieri* (Patagonia).

The situation in Europe is somewhat parallel to that in North America in that two species have a rather wide range in the northern territory. *I. lacustris* and *I. echinospora* are found in the British Isles and on the continent in the northern countries. Aside from these, there are eight other forms on the continent more local in distribution, and three in Mediterranean islands. In France, we find *I. setacea, I. Boryana, I. tenuissima, I. histrix,* and *I. Brochoni;* in Italy, the giant *I. Malinverniana;* in Greece, *I. Heldreichii,* and in Spain, *I. baetica* (probably not a valid species). In the Mediterranean islands, Corsica, Sardinia, or Sicily, are reported *I. dubia, I. velata,* and *I. tegulensis. I. azorica* is reported only from the Azores.

To date, the genus appears much more sparse in Asia, with *I. olympica* for Asia Minor, *I coromandelina* for India, and *I. echinospora* var. *asiatica* and *I. japonica* for Japan.

In Africa, Algeria shows especially marked abundance of forms in that *I. histrix, I. Duriaei, I. adspersa, I. velata* and its variety, *Perralderiana,* all occur here. Farther south, *I. nigritiana* has been reported for the River Niger, and *I. Schweinfurthii* in the Anglo-Egyptian Sudan. In southern Africa, Angola gives us *I. Welwitschii* and *I. aequinoctialis. I. Wormaldii* and the little-known *I. natalensis,* which may prove a valid species, are forms from the Cape.

Oceanica proves very rich in forms, with three each in Australia (*I. Drummondii, I. Muelleri,* and *I. tripus*) and Tasmania (*I. Gunnii, I. elatior,* and *I. humilior*), and two allies in New Zealand (*I. alpina* and *I. Kirkii*).

Floristic Relations.—Some of the Mediterranean forms, as *I. velata, adspersa, Boryana, tegulensis,* and *tenuissima* and *I. velata Perralderiana,* show a very close relation as though originating from a single stock, which may be referred to as the Eur-African stock. No other morphological group as large as this is found in so limited a geographical region. The two New Zealand species, *I. alpina* and *I. Kirkii,* show evident relations to each other. But associated morphologically with these eight forms are many others in widely distant stations, as *I. cubana* of Cuba, *I. Schweinfurthii* of Central Africa, *I. Orcuttii* of southern California. Obviously it is impossible to determine any basic forms here.

In what might be termed the *Echinatae* group, one finds many reports of *I. echinospora* itself in Europe, the closely related *I. Braunii* in our northern territory (the two probably bridge the Atlantic Ocean in the Arctic islands), and a variety in Japan which presents a difficulty in the attempt to ascertain to which it is the more closely related. There are representatives of this group also along the west coast of North America, up to Alaska. Obviously there is a more or less continuous northern band about a large part of the known territory. Discontinuity may be due to lack of present forms or to lack of knowledge of such forms.

The other morphological groups show rather a similar situation to the first-mentioned group, with representatives scattered in north, south, east and west hemispheres.

It may be noted that the distribution of diverse species, of a remarkably conservative genus, is striking in the number of insular and coastal region forms which appear.

Material Examined

The present monograph was suggested to the writer by Dr. J. M. Greenman, under whose guidance the work has come to completion at the Herbarium of the Missouri Botanical Garden. To him especial thanks are due for encouragement, suggestion, and advice in the progress of the problem. The writer is indebted

to the Garden for the use of the excellent collections of *Isoetes*, comprising the collections of two students of the group, Dr. George Engelmann and A. A. Eaton, for the use of the original notes of these workers, and for grants which made it possible to pursue this work. It is also a pleasure to acknowledge the kindness of Dr. Wm. R. Maxon, who placed the material of the United States National Herbarium at the writer's disposal; of Dr. Aven Nelson and Dr. C. O. Rosendahl, who loaned the material from the herbaria of the University of Wyoming and the University of Minnesota, respectively; of Prof. L. R. Abrams, who supplied some west-coast forms from the Dudley Herbarium of Leland Stanford University; of Dr. S. Schönland of South Africa, Dr. D. A. Herbert and Prof. T. G. S. Osborn of Australia, Mr. L. Rodway of Tasmania, and Dr. W. S. Dudgeon of India, for material of exotic species.

The writer has also enjoyed the privilege of examining the sheets of *Isoetes* in the Gray Herbarium, in the Herbarium of the New York Botanical Garden, and in the Field Museum of Chicago. To those in charge who have facilitated this work, she desires to express her appreciation of the privileges enjoyed and the courtesies extended.

In the matter of photographic illustrations, the writer is especially grateful for the suggestions and aid given by Dr. J. W. G. Land of the University of Chicago.

To all others who have by contributions of material, by suggestion, or other evidence of interest, added to the completeness of this paper, the writer expresses sincere gratitude.

Relationships in Genus

The species of *Isoetes* might be considered from the point of view of the sculpture of the megaspore wall as representing a long series from those with simple distinct prominences to those with extended ridges or crests, finally becoming reticulate. In this long series many forms stand out distinctly. But with abundance of material there is often much evidence of intergrading between adjacent forms and even of variation within the same species. As an example of the latter, one might cite the case of *I. Bolanderi* of the west coast of America, a form ordinarily adorned with low tubercles, which on occasion fail to

appear, leaving a smooth surface. As illustration of intergrading between closely related forms, the *I. velata* complex of the Mediterranean region serves well. Here one must use all the available distinctions to hold the forms apart; yet, were these not used, the result would be simply a complex, incapable of treatment as a unit. Examples of pairs of species in which the same difficulty arises are *I. riparia* and *I. saccharata, I. macrospora* and *I. Tuckermani, I. echinospora* and *I. Braunii.* In all these cases, absolute separation on spore characters alone would be a difficult task; other features, even geographical range, may prove invaluable as supplementary points.

In all instances, it has been the aim of the writer to so treat the forms as to avoid points of an insignificant nature and to emphasize what seemed more important features. Only fairly definite varieties have been maintained. In some cases, it has been necessary to reduce long-recognized varieties and forms, in others those of more recent standing. Possibly this has occurred more frequently than usual in a work of this sort. The most obvious explanation for this is related to the relatively rare occurrence of the genus in the experience of most workers. The result of this is the seeming distinctiveness of any single collection made. One other possible result of inexperience is description based on immature material. Many collections of under-ripe plants are made without realization of the absolute necessity of mature characteristics for positive determination.

It is furthermore not always easy to determine from collections, sometimes scant in amount and accompanied by few or no habitat notes, to exactly what extent ecological factors have resulted in variations. The writer is inclined to believe that such variations have at times been the basis for described varieties and has attempted in this work to avoid as far as possible classification of varieties and forms resulting from such factors as the relative dryness of the season.

Species not Examined

Isoetes as a genus is distributed widely over the earth in very local fashion, frequently in remote and inaccessible stations. In such a group, it is not surprising that some forms have been collected only once, nor is it unexpected that representation

should be lacking in America of some of these less well-known forms. In spite of efforts extending over a considerable interval of time, it has not been possible to obtain adequate material of the following described species: *I. Welwitschii, aequinoctialis, Heldreichii, nigritiana, dubia, olympica, Gardneriana, elatior, Muelleri, humilior, triquetra, echinospora* var. *asiatica, tripus, Savatieri, neoguiniense, baetica, natalensis.*

Wherever possible these species have been placed in the keys according to the characters found in the literature. The species descriptions are based either entirely on the original description, directly quoted or translated, or on that plus supplementary material in later accounts. It has been a matter of concern to choose what seemed authentic. Unfortunately, the monograph of Motelay and Vendryès, which should be of great aid here, has so many typographical errors that one lacks confidence in its reliability.

Keys

In the preparation of keys, the attempt has been made to use as evident characters as possible, such as plant size, character of leaf, and similar features. Unfortunately such points are dependent to some extent on external conditions which may prove variable. An effort has been made to take such variations into account; obviously, some errors in judgment, especially because of the use of dried material apart from its habitat, will occur, which in some degree render the key inaccurate. Measurements might better, therefore, be interpreted as suggestive of the probable range rather than as absolute limits.

Furthermore, it has been necessary to utilize minute characters, some of which are not readily determined, particularly in dried material. Previous investigators, as Braun and Engelmann, have stressed this point adequately. The latter further emphasized the skill that even the amateur can develop with the opportunity to study fresh material of several forms, so that standards of comparison may be developed. A little more care is required with the use of dried plants, which involves soaking and more careful methods in dissecting and sectioning.

Again, with these minute characters, such as ligule and degree of velum development, it is very difficult to more than approximate an accurate description. In regard to such a feature as

spore sculpture words prove at times a difficult mode of conveying an exact picture of the various markings. Recourse has therefore been had to photographs, which will serve to counteract the shortcomings of verbal description.

In the case of microspore markings, the point should be borne in mind that in such tiny structures the degree of magnification plays an unusually large role. This is true in much smaller degree of the megaspores. The description for microspores has been based on what may be seen with a magnification approximating 100 diameters, that for megaspores, about 50 to 60 diameters.

Isoetaceae Reichb.

Isoetaceae Reichb. H. G. L. Consp. Reg. Veg. 43. 1828; Dumortier, Anal. Fam., Pl. 68. 1829; Bartling, Ord. Nat. Pl. 13–14. 1830; Endl. Gen. Pl. 68–69. 1838–40; Schnizlein, Icon. Fam. Nat. Reg. Veg. 35 . 1843-46; Ledeb. Fl. Rossica 4: 495. 1853; Underwood, Our Native Ferns & Fern Allies, 121. 1882; Boissier, Fl. Orient. 5: 746. 1882; Kuhn in Martius, Fl. Brasil. 1^2: 646. 1884; Luerrsen, Farnpfl. Deutschl. 845. 1889; Kuntze, Rev. Gen. Pl. 2: 828. 1891-93; Ascherson & Graebner, Syn. Mitteleur. Fl. 1: 163. 1896-98; Sadebeck in Engl. & Prantl, Nat. Pflanzenfam. 1^4: 756. 1901-02; Small, Fl. Southeastern U. S., ed. 1, 24. 1903, and ed. 2, 30. 1913; Clute, Fern Allies, 207. 1905; Piper, Contr. U. S. Nat. Herb. 11: 88. 1906; Eaton in Gray, Man. Bot., ed. 7, 58. 1908; Coulter & Nelson, Bot. Rocky Mts. 24. 1909; Underwood in Britton & Brown, Ill. Fl., ed. 1, 45. 1896; Maxon in Britton & Brown, Ill. Fl., ed. 2, 50. 1913; Rydb. Fl. Rocky Mts. 1053. 1917.

Aquatic to terrestrial herbs with a short unbranched, lobed, subterranean axis producing many dichotomous roots and grass-like leaves, the enlarged bases of which contain solitary, sessile, adaxial sporangia, more or less covered by a thin extension of tissue or velum. Sporangia of two sorts, producing large tetrahedral megaspores and minute powdery microspores, respectively.

ISOETES L.

Isoetes L. Sp. Pl. 1100. 1753; Gen. Pl. 486, gen. no. 1048. 1754; Amoen. Acad. 3:25, gen. no. 1109. 1756; Syst. Nat., ed. 10, 1330, gen. no. 1048. 1759; ed. 12, 697, gen. no. 1184. 1767; ed.

13, 1284, 1322, gen. no. 1184. 1791; Syst. Veg., ed. 13, 792, gen. no. 1184. 1774; Sadebeck in Engl. & Prantl, Nat. Pflanzenfam. 1[4]: 756. 1901-02.

Marsilea L. Fl. Suec. 996. 1745.

Calamaria Dillen. Hist. Musc. 541. *pl. 80. fig. 2.* 1741; Kuntze, Rev. Gen. Pl. 2: 828. 1891-93; Post & Kuntze, Lexicon, 88. 1904.

Subularia Ray, Syn. Meth. Stirp. Brit. 283. 1696.

Cephaloceratodon Genn. Comment. Critt. Ital. [1] no. 2: 111. 1861.

Isoetella Genn. Comment. Critt. Ital. [1] no. 2: 114. 1861.

Perennials, submerged, amphibious, or terrestrial, with a 2-or 3-lobed, short fleshy axis or corm giving rise to numerous branched roots and to a rosette of elongated, somewhat triangular or quadrangular leaves. Leaves with 4 transversely septate, longitudinal air-channels, with central fibro-vascular bundle; peripheral groups of supporting cells present or absent, stomata present or absent. Ligule a small, delicate, triangular extension of tissue on inner face of leaf above the sporangium. Sporangium solitary, sessile, on adaxial side of leaf, contained within a basal cavity, and more or less covered by a membranous tissue, the velum, on the inner leaf face. Sporangia of two types, microsporangia and megasporangia, bearing respectively microspores and megaspores, which on germination develop gametophytes, the former with a single antheridium, the latter with archegonia. Megaspores hemispherical at base, with equatorial ridge, and three other crests joined at apex, with variously sculptured walls. Microspores minute, powdery, usually oval.

Type species *I. lacustris* L. Sp. Pl. 1100. 1753.

Key to Sections

A. Surface of megaspores chiefly tuberculate or spiny.
   a. Megaspores tuberculate ----------§1. **Tuberculatae**
   b. Megaspores spiny ----------§2. **Echinatae**
B. Surface of megaspores irregularly crested or reticulate.
   a. Megaspores irregularly crested ----------§3. **Cristatae**
   b. Megaspores reticulate, at least on basal face ----------§4. **Reticulatae**

Sect. 1. Tuberculatae

§ 1. Tuberculatae. Forms with 2 or 3-lobed corms; megaspores rarely smooth, usually marked with few or many large warts or many small tubercles, chiefly simple.

Key to Species

A. Forms with 3-lobed corms; megaspores marked with few to many large rounded tubercles; microspores rough; leaves mostly slender, usually with peripheral strands and stomata. Chiefly forms of the eastern hemisphere.

a. Velum none or little developed.

α. Terrestrial forms.

I. Leaves few, velum none ---------- *1. I. Welwitschii*

II. Leaves many, velum covering ½–⅔ of sporangium. *2. I. aequinoctialis*

β. Forms not terrestrial in habit.

I. Megaspores more than 400 μ in diameter.

1. Leaves few in number, less than 20.

*Stomata present.

†Peripheral strands well-developed ---------- *3. I. Schweinfurthii*

††Peripheral strands variable (none–6) ---------- *3.5. I. ovata*

**Stomata absent ---------- *4. I. Heldreichii*

2. Leaves more than 20 in number.

*Megaspores 480–540 μ in diameter, with large tubercles ---------- *5. I. coromandelina*

**Megaspores 565–680 μ in diameter, with numerous smaller tubercles ---------- *6. I. setacea*

***Megaspores 660–800 μ in diameter, with elongated coarse processes ---------- *7. I. Malinverniana*

II. Megaspores chiefly less than 400 μ in diameter.

1. Leaves not filiform, more than 25 cm. long ---------- *8. I. cubana*

2. Leaves filiform, less than 25 cm. long.

*Megaspores gray ---------- *9. I. nigritiana*

**Megaspores white ---------- *10. I. adspersa*

b. Velum complete or nearly so.

α Megaspores with few coarse warts.

I. Megaspores becoming dark when wet.

1. Coarse plants, more than 15 leaves, more than 12 cm. in length ---------- *11. I. Boryana*

2. Finer plants, less than 15 leaves, less than 15 cm. in length ---------- *12. I. tenuissima*

II. Megaspores creamy when wet.

1. Leaves chiefly less than 24 cm. in length.

*Leaves slender and short.

†Leaves more than 10 cm. long.

o Megaspores more than 480 μ in diameter ---------- *13. I. dubia*

oo Megaspores less than 480 μ in diameter ---------- *15a. I. velata* var. *Perralderiana*

††Leaves less than 5 cm. long ---------- *14. I. olympica*

**Leaves coarser, chiefly less than 24 cm. in length, rarely longer ---------- *15. I. velata*

2. Leaves longer, chiefly more than 22 cm. in length ---------- *16. I. tegulensis*

β. Megaspores with more numerous regular tubercles.

I. Leaves more than 15 cm. long, more than 10 in number ---------- *17. I. alpina*

II. Leaves less than 15 cm. long, less than 10 in number ---------- *18. I. Kirkii*

B. Forms with 2- or 3-lobed corms; megaspores rarely smooth, usually marked with numerous small tubercles, sometimes confluent; microspores smooth or rough; peripheral strands and stomata variable among species.

a. Corms 3-lobed.

α. Velum none or little developed.

I. Leaves short, less than 11 cm. in length.

1. Stomata absent ---------- *19. I. Gunnii*

2. Stomata present.

*Megaspores less than 470 μ in diameter ---------- *20. I. Drummondii*

**Megaspores more than 420 μ in diameter ---------- *21. I. amazonica*

II. Leaves long, more than 20 cm. in length.
1. Peripheral strands and stomata present ---------*22. I. Gardneriana*
2. Peripheral strands and stomata absent ----------*23. I. elatior*

β. Velum complete.
I. Amphibious; leaves 7 cm. long ----------*24. I. Muelleri*
II. Terrestrial.
1. Leaf-bases persistent, conspicuous, usually spiny ----*25. I. histrix*
2. Leaf-bases sometimes persistent, not conspicuous.
*Leaves more than 13 in number, longer than 8 cm. --*26. I. Nuttallii*
**Leaves less than 15 in number, less than 8 cm. ------*27. I. Orcuttii*

b. Corms 2-lobed.
α. Velum complete.
I. Megaspores dark when wet, small-tuberculate.
1. Megaspores large, more than 600 μ in diameter ----*28. I. humilior*
2. Megaspores small, less than 480 μ in diameter.
*Leaves less than 7 cm. long; megaspores more than 360 μ ----------*29. I. melanospora*
**Leaves more than 7 cm. long; megaspores less than 360 μ ----------*30. I. lithophila*

II. Megaspores white or creamy.
1. Megaspores marked with large warts.
*Warts always simple ----------*31. I. flaccida*
**Warts confluent into bold ridges on the basal face --*31a. I. flaccida* var. *alata.*
2. Megaspores marked with very low tubercles.
*Stomata present ----------*32. I. Lechleri*
**Stomata lacking ----------*33. I. triquetra*

β. Velum narrow, usually covering not more than one-third of sporangium.
I. Megaspores with tubercles frequently confluent into wrinkles.
1. Amphibious; stomata and peripheral strands usually evident.
*Megaspores more than 420 μ in diameter ----------*34. I. Howellii*
**Megaspores less than 420 μ in diameter ----------*34a. I. Howellii* var. *minima*
2. Submerged; stomata few, peripheral strands lacking.
*Leaves more than 6 cm. long, slender ----------*35. I. Bolanderi*
**Leaves less than 6 cm. long, stout ----------*35a. I. Bolanderi* var. *pygmaea*

II. Megaspores with chiefly simple tubercles.
1. Peripheral strands lacking ----------*36. I. Tuerckheimii*
2. Peripheral strands present.
*Megaspores less than 480 μ in diameter.
†Surface of spore smooth or with large simple tubercles. ----------*37. I. mexicana*
††Surface of spore with small tubercles, sometimes confluent. ----------*38. I. melanopoda*
**Megaspores more than 480 μ in diameter ----------*39. I. Butleri*

1. Isoetes Welwitschii A. Br. in Kuhn, Fil. Afr. 196. 1868; A. Br. Sitzb. Naturf. Fr. Berlin, 7. 1867; Motelay & Vendryès, Actes Soc. Linn. Bord. **36**: 388. 1883.

Calamaria Welwitschii Kuntze, Rev. Gen. Pl. **2**: 828. 1891-93.

Corm 3-lobed; leaves 6–15, rigid, straight or slightly curved, firm, very fine, pale green surrounded at base by some dark scales; stomata numerous; peripheral strands 4 primary, accessories none in front, 4 on each side in back; velum very narrow,

almost none; ligule elongated, little shorter than the sporangium; megaspores 300–360 μ and 480–540 μ, dimorphous in same sporangium, ashy when dry, with white markings; warts prominently numerous on the basal face, larger and smaller intermixed, on apical faces all small, very numerous; microspores 30 μ long, 20 μ wide, somewhat acute, with scattered minute inconspicuous tubercles.

Distribution: Huilla, District of Angola, Africa.

No authentic specimens seen.

2. **I. aequinoctialis** Welw. in Kuhn, Fil. Afr. 195. 1868; A. Br. Sitzb. Naturf. Fr. Berlin, 7. 1867; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 365. 1883.

Calamaria aequinoctialis Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves numerous, 30–40 cm. long, rigid, firm; stomata numerous; peripheral strands 4 primary and 18–24 weaker accessory; ligule elongate triangular, shorter than sporangium; velum incomplete, covering ½–¾ of the sporangium; sporangium globose; megaspores dimorphous, 380–480 μ and 550-620 μ in diameter, cinereous, ornamented by white commissural ridges and warts; warts coarse, hemispherical, distant, sometimes doubly confluent, 5–6 on apical faces, solitary or few confluent in smaller megaspores; microspores 30–40 μ long, 25–35 μ thick, strongly obtuse, densely spiny. Description compiled.

Distribution: Angola, in wet prairies of Pungo Andago, 8–1200 m. altitude.

3. **I. Schweinfurthii** A. Br. in Baker, Jour. Bot. 18: 108. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 380. 1883.

Calamaria Schweinfurthii Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 9–25, 25–32 cm. long, firm, gradually tapering to an acute apex, with membranous margin developed 1–3 cm. above level of sporangium; stomata common; peripheral strands 4 (or 6) cardinal, strongly developed, plus 6–8 accessory groups; ligule short, broad triangular; sporangium ovoid to oblong, 4–6 mm. long, with velum none or exceedingly nar-

row; megaspores white, creamy when wet, 400–500 μ in diameter, with few large warts on apical faces, more numerous on basal; microspores 27–32 μ in length, almost smooth.

Distribution: Central Africa, Kingdom Djur.

Specimen examined:

Africa: Anglo-Egyptian Sudan, Jur Ghattas, 7°N., under water, June-July, 1869, *Schweinfurth* (Mo. Bot. Gard. Herb.).

The habit is much like that of *I. Boryana* Dur. except for longer leaves which are commonly coarser than those of the forms *I. velata* and its allies, *tenuissima, tegulensis,* etc., as well as *I. setacea* Bosc. It differs further from these forms in that the velum is lacking, in contrast to being practically completely developed. The megaspores do not turn dark in moisture, as do those of *I. Boryana.*

The species can be delimited from *I. adspersa* A. Br., which is similar in lacking a velum, in that it has far coarser, as well as longer, leaves, that the megaspores are larger (over 400 μ rather than with that as a maximum), and that the microspores are smooth rather than long spinulose.

Contrary to Baker's and Motelay and Vendryès' description, I find the megaspores large tuberculate, with such markings that they might easily be confused with *I. Boryana* Dur., *I. tegulensis* Genn., *I. tenuissima* Bor., etc. I find no evidence of honeycombing in my material, part of which is from the herbarium of Motelay himself.

3.5 **I. ovata** Pfeiffer, n. sp.[1]

Corm 3-lobed; leaves 7–15, 6–24 cm. long, slender, tapering to apex, with basal membranaceous margins but briefly extended; stomata present; peripheral strands lacking or six in number; ligule deltoid, with broad base; sporangium small, ovoid, 2.5–4 mm. long, lacking a velum; megaspores cream-colored, 520–830 μ in diameter, with high well-rounded large tubercles, seldom becoming somewhat vermiform; commissural ridges decidedly

[1] **I. ovata** sp. nov. Cormus trilobatus. Folia numero 7–15, longitudine 6–24 cm., angusta, versus apicem attenuata, basi membranacea breviter dilatata, stomatibus instructa et fibrosis peripheriis vel nullis vel numero sex instructa. Lingula triangularis, basi lata. Sporangium ovatum, parvulum, longitudine 2.5–4 mm., sine velo. Macrosporae gilvae, diam. 520–830 μ, tuberculis crassis prominulis, raro aliquantulum verruculosis ornatae, costis commissuris teretibus, aliquando decussatim rugosis. Microsporae longitudine 31–36 μ, leviter reticulatae.

rounded, and occasionally cross-wrinkled; microspores fawn-colored, 31–36 μ, lightly reticulate, with ridges spine-like in silhouette.

Distribution: British Guiana.

Specimens examined:

British Guiana: pools by shore of Mazaruni River, Demerara, December, 1890, *Jenman* (N. Y. Bot. Gard. Herb.), TYPE; Baracarra, Mazaruni River, Demerara, December, 1890, *Jenman* (N. Y. Bot. Gard. Herb.).

4. **I. Heldreichii** Wettst. Verh. K. K. Zool.-Bot. Ges. Wien 36: 239–240. *pl. 8.* 1886, whence the following description:

Corm 3-lobed, 3–6 mm. long, 3–7 mm. broad; leaves 3–8, fine, flexuous, green, smooth, 10–25 cm. long; no peripheral strands or rarely one dorsal; no stomata; ligule obovate-acute, very finely and irregularly cut; sporangia 4–6 mm. long, without velum; megaspores 14–36 in number, creamy white, globose, inconspicuously trigonous, about 660 μ in diameter, warty [plate shows 12 or so warts on one of upper faces]; microspores powdery, elliptical, with narrow winged margin, and marked with short spines.

Distribution: Greece, plains of Thessaly.

Specimen examined:

Greece: amphibious in wet places, schistose substratum, in lower region of Pindus Mountains, alt. 3500′, 5 July, 1885, *Heldreich 899* (Gray Herb.).

5. **I. coromandelina** L. fil. Suppl. Pl. 447. 1781; A. Br. Verh. Bot. Ver. Brandenb. 4: 327. 1862; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 380. *pl. 15. fig. 7.* 1883.

I. brachyglossa A. Br. Verh. Bot. Ver. Brandenb. 4: 327. 1862.

I. capsularis Griffith, not Roxb., in Posth. Papers, Cryptog. Pl. 572–575. *pl. 116–118.* 1849.

Calamaria coromandelina Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 20–60, large, with very wide membranous wings at base, extending above sporangium level; stomata numerous in upper region, lacking in basal portion of leaves; peripheral strands present, 4 very strongly developed with sev-

eral weaker accessory; ligule conspicuous, very wide and short, often appearing truncate in older leaves, but pointed in young; sporangium large, maximum about 12 mm. in length and 9 mm. in width; velum none; megaspores white when dry, gray when moist, 480–540 μ in diameter, somewhat flattened, marked with numerous large tubercles, closely arranged and occasionally extended into very short rounded ridges; microspores red-brown or paler at maturity, 26–33 μ, chiefly 30 μ, smooth.

Distribution: India.

Specimens examined:

India: Madras, 1919, *Fyson* (Mo. Bot. Gard. Herb.); Peninsula of India, without date, *Royle* (?) (Gray Herb.); "Peninsula Ind. orientalis," *Herb. Wight. Cryptogamia 4* (N. Y. Bot. Gard. Herb.); near Seven Pagodas, Madras, February, 1922, *Kashyap* (Mo. Bot. Gard. Herb.).

Dr. W. S. Dudgeon, through whose courtesy material from India was obtained, gives the assurance of local botanists that there is but one species in India. The chief difference between the descriptions of *I. coromandelina* and *I. brachyglossa* seems to be one of leaf length, which would not be a character of specific rank.

The specimens examined were very large in the sporangium region, reminding one of the giant *I. Malinverniana* of Europe. All mature sporangia proved to bear megaspores. No published record for microspores appears available in the literature concerning either *I. coromandelina* or *I. brachyglossa*. The measurements made as reported above were made from spores scattered among the sporophylls, sometimes in small groups but in all cases distinctly recognizable as *Isoetes* microspores. Some are unusually brilliant with orange-red coloring, possibly due to chemicals.

6. **I. setacea** Bosc, "Dict. d' Hist. Nat." in Delile, Mem. Mus. Paris 14: 100–119. *pl. 6–7.* 1827; (Lamarck, Encycl. Meth. 3: 314. 1789.) (?); A. Br. Verh. Bot. Ver. Brandenb. 4: 30. 1862; Baker, Fern Allies, 129. 1880, and Jour. Bot. 18: 106. 1882; Milde, Fil. Eur. 286. 1867; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 376. *pl. 11. fig. 1–2.* 1883.

Calamaria setacea Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 10–40 (rarely 60), 12–40 cm. long, light green, firm but not stiff, tapering to apex, with wide membranaceous margin at base gradually narrowed to disappearance 1–2 cm. above sporangium level; stomata present in upper parts of leaves; peripheral strands variable, but chiefly 6 plus accessory strands; ligule longer than wide; sporangia 4–6 mm. long, lightly marked with sclerenchyma cells; velum none; megaspores white, 564–680 μ (rarely 800) in diameter, densely crowded on all faces with small warts or tubercles; commissural ridges prominent and wide; microspores 27–37 μ long, usually with slightly crenulate margins and with low crest.

Distribution: Montpellier, Herault, France.

Specimens examined:

France: Grammont, near Montpellier, December, 1820, *Ballard* (Gray Herb.); Montpellier, *ex Herb. Engelmann* (Mo. Bot. Gard. Herb.); mare de Grammont pres Montpellier, *Delile* (N. Y. Bot. Gard. Herb.); lac de Grammont, August, 1837, *de Gerard* (Mo. Bot. Gard. Herb.); Montpellier, Grammont, 21 March, 1840, *Bubani* (U. S. Nat. Herb.); Montpellier, 1842, *Wanderley* (Mo. Bot. Gard. Herb.); Montpellier, Grammont, 30 June, 1842, *without collector* (Mo. Bot. Gard. Herb.); pools of plateau of Roquehaute, 7 June, 1863, *Durieu 21* (N. Y. Bot. Gard. Herb.); pond near Montpellier, 8 June, 1857, *Cosson* (Gray Herb., Mo. Bot. Gard. Herb., and N. Y. Bot. Gard. Herb.); near Beziers (Herault), and Juire, 1879, *Gautier* (N. Y. Bot. Gard. Herb.); Montpellier, 1866, *Cosson* (Mo. Bot. Gard. Herb.); marsh, Roquehaute near Beziers (Herault), 3 June, 1862, *Cosson* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.); pool, Roquehaute, June, 1862, *Durieu* (Mo. Bot. Gard. Herb.); "in almost all the ponds of the volcanic plateau of Roquehaute, Herault," 17 May, 1864, *Motelay* (Mo. Bot. Gard. Herb.); ponds of Roquehaute, 11 May, 1864, *Cheveneau* (U. S. Nat. Herb.); pond of Roquehaute near Beziers, June, 1869, *Cheveneau* (Gray Herb.); near Montpellier, Grammont, 6 June, 1884, *without collector* (U. S. Nat. Herb.); pond at Grammont near Montpellier, November, 1876, *Duval-Jouve* (Gray Herb.); Grammont near Montpellier, 10 May, 1888, *Herb. Fac. Scient. Monsp.* (U. S. Nat. Herb.); Portiragnes (Herault), ponds in plateau of Roquehaute, 1 April, 1888,

Neyraut (Mo. Bot. Gard. Herb.); Montpellier, in pond of the woods of Grammont, 16 June, 1889, *Herb. Copineau* (U. S. Nat. Herb.); pond near Montpellier, 1892, *de la Perraudiere* (Mo. Bot. Gard. Herb.); ponds of Roquehaute, Herault, 15 May, 1895, *Mandon* (Mo. Bot. Gard. Herb.); Portiragnes, Roquehaute, 2 May, 1896, *Sennen* (Mo. Bot. Gard. Herb.); Portiragnes, Herault, ponds in plateau of Roquehaute, 6 November, 1897, *Neyraut* (Mo. Bot. Gard. Herb.); plateau of Roquehaute, May, 1898, *Herbarium Normale, I. Dorfler, (Neyraut) 3698,* (U. S. Nat. Herb.); Montpellier, Herault, 20 February, 1898, *Mandon* (Univ. Minn. Herb.); Portiragnes, 8 May, 1898, *Neyraut* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Montpellier, in the ponds of Grammont, 3 July, 1907, *Societe Cenomane d'Exsiccata* [*Jean de Vichet*] *482* (Mo. Bot. Gard. Herb.); Lac de Grand Lieu, 27 September, 1880, *without collector* (Mo. Bot. Gard. Herb.); without locality or date, *DeCandolle* (N. Y. Bot. Gard. Herb.).

Historically one of the oldest species of *Isoetes*, *I. setacea* Bosc was the subject of a detailed and interesting account by Delile, who credited Bosc with the name for this species of central France, as published in Dictionnaire d'Histoire Naturelle. The lack of velum associated with the numerous small tubercles of the megaspore and the rather firm but flexuous, fine leaves, make distinctive points of difference between this form and the *I. velata* series (complete velum), *I. adspersa* A. Br. (large warts on smaller spores), and *I. Malinverniana* Genn. (larger tubercles on larger spores in much coarser plant).

The distribution of peripheral strands is the most variable possible; most frequently there are six at the cardinal points, with numerous other groups irregularly arranged beneath a much thickened epidermal layer. Sometimes these groups are so numerous as to make an almost continuous band. On the other hand, the cardinal bundles may be very weak; or only four of them may be developed; or, most extreme situation of all, there may be no development of these thickened cells. The different possible arrangements may be found in the same plant, where the base of the leaf shows no peripheral strands and the apex a fairly strong development. Doubtless there is a response to external factors.

7. I. Malinverniana Cesat. & De Not. Ind. Sem. Hort. Reg. Bot. Genuensis, 1858; Ann. Sci. Nat. Bot. 4: 381. 1859; Linnaea 30: 741. 1859-60; Baker, Jour. Bot. 18: 106. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 342. 1883.

Calamaria Malinverniana Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 90–100, 30–80 cm. long, rich green, prismatic, subulate, with narrow membranous margin little extended (0.5–1.0 cm.) above level of sporangium; stomata few; peripheral strands 6; ligule lanceolate; sporangia oblong, 2–2.5 cm. long; velum none; megaspores white when dry, ashy when wet, 660–800 μ in diameter, with long coarse processes (sometimes 80 μ in length), rounded at tip, extending on all faces between narrow commissural ridges wavy in outline, frequently with large compound knob occurring on upper face in angle formed by ridges; microspores 33–38 μ (rarely 29 μ) in length, spiny.

Distribution: Piedmont, in Italy.

Specimens examined:

Italy: in slow-flowing water in aqueducts, "Greggio and Oldenico," Piedmont, fruiting all summer, through the fall, even into winter, 1865, *Cesati* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); near Oldenico, Piedmont, 3 May, 1863, *Ascherson* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.); ditches about Vercelli, "note de Durieu dans son herbier: recu vivant de M. Malinverni, le 25 Octobre, 1867," *Malinverni* (Mo. Bot. Gard. Herb.); Piedmont, prov. Novara, in fountains and aqueducts, submersed, floating, throughout year, 1910, (*Gola*) *Fiori & Béguinot 1606* (Gray Herb.); near Oldenico, Piedmont, 1859, *Malinverni,* (N. Y. Bot. Gard. Herb.).

This species is the giant form of Europe in leaf number and length. The size of its megaspores is equalled only by that of *I. Duriaei* Bory, which, however, in other features is a much smaller plant. The coarse, long processes, visible to the naked eye, and the peculiar large grains, compounded as it were from a number of warty prominences, are definitely characteristic of this species.

8. I. cubana Engelm. Trans. St. Louis Acad. Sci. 4: 389. 1882; Sauvalle, Fl. Cub. 203. 1873, name only; Baker, Jour. Bot.

18: 110. 1880, and Fern Allies, 133. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 350. 1883.

Calamaria cubana Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 20–40, 15–40 cm. long, bright green, firm, of medium fineness, gradually tapering to a point, with membranaceous margin extended 2–5 cm. above sporangium level; brown papery scales sometimes produced from leaf bases; stomata rare, chiefly near tips; peripheral strands 6; ligule short, broad triangular; sporangium oval, 4–7 mm. long, with very narrow velum; megaspores white, 290–400 μ long, closely marked with large round depressed tubercles on each face; microspores 26–30 μ long, tuberculate.

Distribution: western Cuba, Pinao del Rio.

Specimens examined:

Cuba: "in rivulets (on the bottom) of the pinewood, Western Cuba, Pinao del Rio, 1866," *Wright 3912* (Mo. Bot. Gard. Herb., Gray Herb., U. S. Nat. Herb., N. Y. Bot. Gard. Herb.).

This form resembles the *I. velata* series in having large tubercles on the megaspores, which differ, however, in not being restricted to a central group on the apical faces but in covering practically the whole face; furthermore, the tubercles instead of being wart-like and much-raised are depressed. Of the 3-lobed forms, it resembles *I. adspersa* A. Br. in the small megaspores, less than 400 μ, and in the absence of a velum.

9. **I. nigritiana** A. Br. in Kuhn, Fil. Afr. 196. 1868; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 388. 1883.

Calamaria nigritiana Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 12–15, 14–18 cm. long, flexuous, very fine, rigid, pale green, opaque, with numerous stomata and poorly developed peripheral strands or none; sporangia pale, globose; velum very narrow; megaspores small, gray, with a single tubercle on each apical face, placed centrally within the triangle; on the lower face, several smaller, placed variably.

Distribution: Africa, Nigeria, along the Niger River, Nupe.

Description from Kuhn, Motelay and Vendryès, and Sadebeck in Engl. & Prantl.

10. I. adspersa A. Br. in Bory & Dur. Expl. Sci. Alg. *pl. 37. fig. 3.* 1846-49; Milde, Fil. Eur. 286. 1867; Baker, Fern Allies, 129. 1881, and Jour. Bot. 18: 106. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 381. *pl. 11. fig. 5–6.* 1883.

I. setacea Perreymondii Bory, Compt. Rend. Acad. Paris 18: 1165. 1844, and Flora 27: 716. 1844.

I. lineolata Dur. in Motel. & Vendr. Actes Soc. Linn. Bord. 36: 381. 1883.

Calamaria adspersa Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 9–25, 7–16 cm. long, very slender, filiform, attenuated, with wide membranaceous margin at base extending 1–2 cm. above level of sporangium; bases sometimes persistent as brown scales; stomata common; peripheral strands 4 or more; ligule longer than wide, ovate-acuminate; sporangia oval, 3–5 mm. long, spotted with brown sclerenchyma cells; velum very narrow; megaspores white, sharply angled, 328–400 μ in diameter, with few coarse warts and very prominent commissural ridges; microspores light brown, 27–34 μ long, spinulose, sometimes wing-crested.

Distribution: Algeria.

Specimens examined:

Algeria: Oran, May, 1844, *Durieu* (Mo. Bot. Gard. Herb.); dry flats in field, Oran, 28 April, 1842, *ex Herb. Motelay* (Mo. Bot. Gard. Herb.); near Oran, 12 June, 1844, *Bory* (Gray Herb.); along old route from Figuiers to Oran, 24 April, October, 1852, *Herb. des Flores Européenes (Balansa) 25* (Mo. Bot. Gard. Herb. and Gray Herb.); Plateau du Djebel Santo, near Oran, May, 1857, *Flores Regionales Algeria (Weddell) 16* (U. S. Nat. Herb.); Flora Africae borealis, 1910-1911, Dj. Habibi, *Gandoger* (Mo. Bot. Gard. Herb.); Oran, 1907, *Gandoger* (Mo. Bot. Gard. Herb.); in exsiccated pools, mountain Djebel Santo, near Oran, 14 March, 1876, *Warion 188* (Gray Herb.).

The above species can be readily distinguished from *I. velata* A. Br. by its narrow velum (in contrast to one almost complete), by its narrower leaves, and most markedly by the smaller megaspores, of which the markings resemble more nearly those of *I. Boryana* Dur.

11. I. Boryana Dur. Bull. Soc. Bot. Fr. 8: 164. 1861; Milde, Fil. Eur. 284. 1867; Baker, Fern Allies, 130. 1887, and Jour. Bot. 18: 107. 1886; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 353. *pl. 10. fig. 1–10.* 1883.

Calamaria Boryana Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves (10) 15–30, 12–20 cm. long, loosely arranged at base, rather coarse, tapering gradually to apex, with wide membranaceous margin suddenly narrowed a few millimeters above sporangium level; stomata numerous; peripheral strands 6, frequently with accessory strands; ligule deltoid; sporangia subglobose to oblong, 3–8 mm. long, sometimes with brown spots; velum complete or nearly so; megaspores white when dry, dark when wet, 400–640 μ in diameter, marked with few large and scattered smaller warts, sometimes confluent on the basal face to produce very short, irregularly lobed, rounded elevations; microspores reddish-brown, 26–33 μ long, spinulose.

Distribution: France, Landes.

Specimens examined:

France: "Etang de Cazau," Landes, 7 September, 1863, *Durieu* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.), TYPE; "Etang de St. Julien," Borne, Landes, 31 July, 1863, *Durieu* (Mo. Bot. Gard. Herb.); "Etang de Cazau," near Bordeaux, September, 1860, *Durieu* (Mo. Bot. Gard. Herb., Gray Herb., and N. Y. Bot. Gard. Herb.); Etang de Cazau, near Sanguinet, 3 September, 1860, and 14 July, 1861, *Schultz (Durieu) 778* (N. Y. Bot. Gard. Herb., Mo. Bot. Gard. Herb., and U. S. Nat. Herb.); in field, Etang de Cazau, 4 September, 1861, *Gay* (Gray Herb.); Sanguinet, 5 July, 1863, *Durieu* (Mo. Bot. Gard. Herb.); Sanguinet, 19 July, 1863, *Durieu* (Gray Herb.); Etang de Sanguinet, near Cazau, July, 1868, *Durieu* (N. Y. Bot. Gard. Herb.); Sanguinet (Landes), 23 July, 1900, *Neyraut* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); Etang d'Aurelion (Landes), June, 1861, *Foucault,* (Mo. Bot. Gard. Herb.); Etang de Cazau, 17 August, 1890, *Neyraut* (Mo. Bot. Gard. Herb.); near Seignosse (Landes), 2 August, 1891, *Neyraut* (Mo. Bot. Gard. Herb.); Parentis (Landes), 9 July, 1893, *Neyraut* (Mo. Bot. Gard. Herb.); Sanguinet, 27 September, 1860, *Motelay 1903* (U. S. Nat. Herb.); "mixed with Durieu's lacustris,

Lac de Guery, 23–27 August, 1861, Motelay misit," *Herb. Eaton* (Mo. Bot. Gard. Herb.).

12. **I. tenuissima** Boreau, Bull. Soc. Ind. d'Angers, 269. 1850; Grenier & Godron, Fl. Fr. 3: 650. 1855-56; Milde, Fil. Eur. 285. 1867; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 351. 1883; Baker, Fern Allies, 131, 1887, and Jour. Bot. 18: 107. 1880; Bot. Centralbl. 57: 246. 1894.

I. Viollaei F. Hy, Jour. de Bot. 8: 96. 1894.

Calamaria tenuissima Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 7–12, 7–12.5 cm. long, 3-angled, erect, slender, gradually tapering from base to apex; stomata fairly common; peripheral strands not evident; ligule small, triangular; sporangia globose, 2–3 mm. long, with velum complete or nearly so; megaspores creamy in color when dry, brown when wet, 400–480 μ in diameter, with few large warts (4 or 5) on upper faces, more on basal (about 13–15); commissural ridges prominent; microspores 25–33 μ long, with numerous long, blunt spines.

Distribution: Province of Riz-Chauvron, Haute-Vienne, France.

Specimens examined:

Central France: Haute-Vienne, without date, *Boreau* (Gray Herb.); Riz-Chauvron, 25 September, 1856, *Schultz* (*Chaboisseau*) *395* (Mo. Bot. Gard. Herb.); Riz-Chauvron, Haute-Vienne, 5 September, 1865, *Schultz* (*Deloynes*) *395b.* (U. S. Nat. Herb.); Riz-Chauvron, September, 1857, *Chaboisseau* (Mo. Bot. Gard. Herb. and Gray Herb.); Riz-Chauvron, Haute-Vienne, 7 September, 1859, *Chaboisseau* (N. Y. Bot. Gard. Herb.); Riz-Chauvron, 20–25 September, 1860, *Chaboisseau 70* (Mo. Bot. Gard. Herb. and Gray Herb.); Riz-Chauvron, 1864, *Motelay* (Mo. Bot. Gard. Herb.); Riz-Chauvron, 8 September, 1865, *Chaboisseau* (Mo. Bot. Gard. Herb.); Etang du Riz-Chauvron, September, 1869, *Durieu* (Gray Herb.); near St. Léomer, Vienne, 7 August, 1893, *Violleau 427* (Mo. Bot. Gard. Herb.); Etang de La Harpe near Loreux (Loir et Cher), 28 July, 1883, *Martin 19* (N. Y. Bot. Gard. Herb.); "La Harpe," Loreux (Loir et Cher), 7 August, 1876, *Le Grand* (N. Y. Bot. Gard. Herb.); St. Léomer, Vienne, August, 1893, *F. Hy*

(Mo. Bot. Gard. Herb.); Riz-Chauvron, August, 1893, *F. Hy* (Mo. Bot. Gard. Herb.).

Germany: with *lacustris*, Wjellingsee, Bütow, Pomerania, *Doms* (Mo. Bot. Gard. Herb.).

The specimen from Pomerania is a single one, which shows undoubted *tenuissima* characters, both in vegetative and reproductive features. It is a question whether it was not placed with the Pomerania material originally through an error. No other stations than those in central France have been brought to light to date, save this distant one, as indicated by a single plant.

Hy's species *I. Viollaei* was based on *I. tenuissima* Bor. specimens which showed brown lines about the sporangium at the base of the leaf. At best, this character would serve only in separating a form. Several American species show in the same stand both pallid and spotted-leaved forms, as *I. melanopoda* Gay & Dur. The species is very closely related to *I. Boryana* Dur., rather than to *I. aspersa*, as Grenier and Godron indicate.

13. I. dubia Genn. Comment. Critt. Ital. (2): 104. 1861; A. Br. Monatsber. K. Akad. Wiss. Berlin, 606. 1863; Milde, Fil. Eur. 282. 1867.

Calamaria dubia Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 18–22 cm. long, yellow-green, soft, fine, narrowly wing-margined at the base; ligule very broadly ovate; weak peripheral strands with no accessories; sporangia completely covered by velum, devoid of colored cells; megaspores 480–560 μ, similar to *I. velata*, but with commissures somewhat smaller and sharper, causing sharper angles in joining the equator; warts smaller and less distinct; microspores of two sorts, some similar to *I. velata*, others with exospore extended into wing, cristate and lobed on back.

Distribution: Island of Magdalena, Sardinia.

Description from Braun and Milde.

14. I. olympica A. Br. in Milde, Fil. Eur. 285. 1867; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 362. 1883.

Calamaria olympica Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 3–5 cm. long, light green, ½ mm. broad above sheath; stomata numerous; peripheral strands less devel-

oped than in *I. Boryana* and *I. tegulensis;* sporangia small, 2 mm. long, without thickened cells; velum covering 1/3–2/3 of sporangium; megaspores white, 360–440 μ, covered with unequal hemispherical warts on the basal face, with smaller more numerous tubercles, often inconspicuous, on the apical faces; microspores 30 μ long, 20 μ wide, spinulose.

Distribution: small pools in granite plains of Olympus near Brussa of Bithynia.

Description based on Milde's data.

15. I. velata A. Br. in Bory & Dur. Expl. Sci. Alg. *pl. 37. fig. 1.* 1846-49; Genn. Comment. Critt. Ital. 103. 1861; A. Br. Monatsber. K. Akad. Wiss. Berlin, 602. 1863; Milde, Fil. Eur. 280. 1867; Franchet, Fl. Loir et Cher, 747. 1885, and Bull. Soc. Bot. Fr. 31: 349. 1884; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 384. *pl. 15. fig. 8–9.* 1883.

I. decipiens Bory, Flora 29: 719. 1846.

I. setacea var. *Delilei* Bory, Compt. Rend. Acad. Paris 18: 1165. 1844, and Flora 27: 716. 1844.

I. Chaboissaei Nym. Consp. Fl. Eur. 871, name only.

Calamaria longissima Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 5–30, sometimes 40, 8–24 cm. long, tapering to apex, rather fine, with wide membranaceous border at base extending ½ cm. above sporangium level; base of leaf sometimes persisting as a brown papery scale; stomata numerous; peripheral strands usually 6, rarely only 4, frequently with weaker accessory strands in variable number; ligule triangular lanceolate; sporangium 3–5 mm. long, nearly (4/5) to completely covered by velum; megaspores 420 (360) –580 μ in diameter with few large warts on upper faces (3–10), and with mixed large and small warts on basal face; microspores red-brown, 26–33 μ long, densely spinulose.

Distribution: Sicily, Corsica, Algeria.

Specimens examined:

Sicily: near Misilmer, 24 May, 1856, *Pl. Siculae 242 (Huet de Pavillon)* (Mo. Bot. Gard. Herb.).

Corsica: near Bonifacio, on granite, rare, April, 1893, *Reverchon* (Mo. Bot. Gard. Herb.); Corsica, *Rabenhorst Crypt. Vasc. Eur. (Reveliere) 105* (N. Y. Bot. Gard. Herb.).

Algeria: wet places near Bona, about 1860, *LeTourneux* (Mo. Bot. Gard. Herb.); ponds of Chaïba near Coléah, 18 April, 1859, *Herb. Font. norm. (Clauson) 99* (Gray Herb.); Daïa, 29 April, 1859, *Herb. Font. norm. (Clauson) 99 bis* (Gray Herb.); Lac de Ouled Dieb., between Bone and LaCalle, *LeTourneux* (Gray Herb.); swamps, Boudom, 12 April, 1861, *Frag. Fl. Alg. Exsic. 499 (Bourlier)* (U. S. Nat. Herb.); mares de Bou Zegart between Oued Khamis and Djebel Azieb Dahra, Prov. Oran, 20 May, 1875, *Warion Pl. Atl. Sel. (Cosson) 189* (Gray Herb. and U. S. Nat. Herb.); Maison Cairee, April, 1878, *Debeaux* (N. Y. Bot. Gard. Herb.); without definite locality, 1906, *Gandoger* (Mo. Bot. Gard. Herb.).

15a. Forma longissima Pfeiffer, comb. nov.

I. longissima Bory & Dur. Compt. Rend. Acad. Paris 18: 1165. 1844.

I. velata var. *longissima* A. Br. in Bory & Dur. Expl. Sci. Alg. *pl. 37. fig. 2.* 1846-49.

Differs from the species in the greater leaf length, as much as 50–65 cm. in the larger plants. There is a tendency toward a smaller number of leaves (8–12).

Distribution: Algeria.

Specimens examined:

Algeria: LaCalle, May, 1844, *Durieu* (Mo. Bot. Gard. Herb.); LaCalle, May, 1844, *Bory* (Gray Herb.); inundated prairies, 24 June, 1844, *Motelay* (Mo. Bot. Gard. Herb.); LaCalle, 1864, *Durieu* (Gray Herb.); LaCalle, June, 1884, *Debeaux* (U. S. Nat. Herb.).

From the presence of persistent papery brown bases of leaves in some specimens it seems likely that this form may assume practically a terrestrial habit, as in *I. Nuttallii* A. Br. and *I. Butleri* Engelm.

The species shows great variability, and its close allies, differing from it in sometimes inconspicuous features, are correspondingly difficult to delimit. Braun and Engelmann were eventually inclined to consider *I. Boryana, I. tenuissima, I. Perralderiana, I baetica, I. tegulensis, I. dubia* and *I. longissima* as forms or subspecies of *I. velata.* There is doubtless a complex here, which properly should be solved by those able to work with an abun-

dance of living material of the forms concerned. A relatively small representation of dried material is inadequate for the problem. *I. longissima* is reduced here to a form since there seems no basis for separation but leaf length. *I. Perralderiana* is reduced to a variety, differing from the species in having more slender leaves and smaller megaspores. The other species are retained in their present rank with the knowledge that they might readily be reduced to varieties, if geographical limitations were not distinct.

15b. Var. **Perralderiana** Pfeiffer, comb. nov.

I. Perralderiana Dur. & LeTourn. in Kralik, Pl. Alg. Exsic. 157; Milde, Fil. Eur. 282. 1867; Kuhn, Fil. Afr. 196. 1868; Baker, Jour. Bot. 18: 107. 1880, and Fern Allies, 130. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 354. *pl. 11. fig. 7, 8, 9.* 1883.

Calamaria Perralderiana Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Like the species in habit except for very fine leaves; megaspores 380–475 μ in diameter, marked with a few large warts and many smaller ones; microspores 26–33 μ long, finely, densely spinulose, sometimes crested.

Distribution: Algeria.

Specimens examined:

Algeria: pool of the fountain of Aïn Sumta, by the gorges Akfadou, eastern Kabylie, 1 August, 1861, *Cosson* (Gray Herb.), TYPE; "cultivated by Durieu at Jardin de Botanique de Bordeaux, coming from Jurajura", 11 July, 1871, *LeTourneux* (Mo. Bot. Gard. Herb.).

16. I. tegulensis Genn. Comment. Critt. Ital. (2): 106. 1861; Milde, Fil. Eur. 283. 1867; A. Br. Monatsber. K. Akad. Wiss. Berlin, 608. 1864; Fl. Ital. 1867; Baker, Jour. Bot. 18: 107. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 363. *pl. 11. fig. 3–4.* 1883.

I. Tiguliana Genn. Comment. Critt. Ital. (1): 42. 1861.

Calamaria tegulensis Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 5–20, 20–30 cm. long, yellow-green, very fine, erect, with narrow membranaceous margins little elongated

above sporangium level; stomata common; peripheral strands 6; ligule small triangular; sporangia oval, 4–6 mm. long, almost or completely covered by velum; megaspores white, 400–520 μ (rarely 600) in diameter, with large well-rounded tubercles on all faces, sometimes with scattered small additional warts on upper faces; commissural and equatorial ridges frequently nodulose; microspores fawn-colored, 26–33 μ long, conspicuously spinulose, sometimes slightly crested.

Distribution: Sardinia.

Specimens examined:

Sardinia: submersed in aqueducts, near Pula, 22 May, 1863, *Ascherson & Reinhardt* (Mo. Bot. Gard. Herb.); Pula, June, 1863, *Ascherson & Reinhardt* (Mo. Bot. Gard. Herb. and Gray Herb.); Pula, June, 1863, *Ascherson* (N. Y. Bot. Gard. Herb.).

This species is one of the forms very closely related to *I. velata* A. Br. It may be distinguished partly by greater length of leaves, which are finer, and partly by the tendency toward smaller megaspores.

17. I. alpina Kirk, Trans. N. Z. Inst. 7: 377. *pl. 25.* 1875; Baker, Fern Allies, 127. 1887, and Jour. Bot. 18: 70. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 368. 1883.

Calamaria alpina Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 10–50, 10–40 cm. long, dark green, stout, rigid, tapering to a point, with a wide membranaceous margin narrowed immediately above sporangium; stomata present but not numerous; peripheral strands lacking; ligule short, ovate-triangular; sporangium oblong, 5–7, rarely 9, mm. in length; velum complete; megaspores white when dry, brown-black when wet, 400–520 μ (rarely only 320) in diameter, chiefly smoothish, sometimes lightly marked with large tubercles, few in number; microspores rusty-brown, 24–31 μ in length, with numerous spines.

Distribution: New Zealand.

Specimens examined:

New Zealand: Lake Guyon, So. Isl., without date, *Kirk* (N. Y. Bot. Gard. Herb.); Lake Guyon, Nelson, alt. 3000 ft., *Kirk 239* (U. S. Nat. Herb. and Gray Herb.); Lake Guyon, Nel-

son, *Kirk 136* (U. S. Nat. Herb.); Lake Guyon, *Kirk* (Mo. Bot. Gard. Herb.); Lake Rotoiti, alt. 1800 ft., January, 1881, *Cheeseman 56* (N. Y. Bot. Gard. Herb.); Lake Rotoiti, alt. 1800 ft., 1 January, 1881, *Cheeseman* (U. S. Nat. Herb. and Mo. Bot. Gard. Herb.); Lake Guyon, 3000 ft., *Hector* (Gray Herb.); Lake Rotoiti, Nelson, January, 1898, *Cheeseman* (Gray Herb.).

Kirk's material from Lake Guyon shows rather shorter, stouter habit in the leaves, which do not exceed 17 cm. in any case. Cheeseman's material derived from Lake Rotoiti invariably shows longer leaves, from 25–40 cm., coarse, but appearing more flexuous. Since most of the material is unfortunately lacking in dates, it is impossible to tell whether the difference in size is to be related to seasonal change, ecological factors, or morphological variation. All material is therefore included under the species.

18. I. Kirkii A. Br. Monatsber. K. Akad. Wiss. Berlin, 2. 1869; Kirk, Trans. N. Z. Inst. 2:107 *pl. 7.* 1875.; Baker, Fern Allies, 127. 1887, and Jour. Bot. 18: 69. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 390. 1883.

Calamaria Kirkii Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 5–15, 7–13 cm. long, medium slender, rather abruptly attenuate at the tip to a very long fine setaceous apex; stomata rare, even at tip; peripheral strands lacking; ligule short, triangular-ovate; sporangia globose, 2–3 mm. in length, completely covered by velum; megaspores white, 460–580 μ in diameter, marked on all surfaces with numerous closely set small tubercles, with very slight tendency to confluence on the basal face; microspores small, 17–25 μ, smooth.

Distribution: mountain lakes in New Zealand.

Specimens examined:

New Zealand: Whangape Lake, *Kirk* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.), COTYPE; Whangape Lake, *Hector* (Gray Herb.); Lake Tekapo, Canterbury, South Isl., 7 January, 1883, *Cheeseman* (U. S. Nat. Herb.); ponds near Lake Tekapo, Canterbury Alps, alt. 2000 ft., *Cheeseman* (Mo. Bot. Gard. Herb.); Lake Whangape, 1882, *ex herb. Martindale* (*Cheeseman coll?*) (Mo. Bot. Gard. Herb.); Lake Whangape, Waikato, N. Isl., *Cheeseman* (Mo.

Bot. Gard, Herb.); Whangape Lake, January, 1879, *Cheeseman* (Gray Herb.).

19. I. Gunnii A. Br. in Herb. Hooker. 1866; A. Br. Monatsber. K. Akad. Wiss. Berlin, 535. 1868; Baker, Fern Allies, 124. 1887, and Jour. Bot. 18: 66. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 347. 1883.

Isoetes sp. Hooker, Fl. Tasm. 2: 158. 1860.

I. lacustris (L.) Rodway, Tasm. Fl. 279. 1903.

Calamaria Gunnii Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 30–50, 3–13 cm. long, stout, tough, abruptly-pointed at tip, with wide membranaceous border at base, continued upward 4–6 times the length of sporangium; stomata and peripheral strands none; ligule short, with cordate base; sporangium oblong, 3–6 mm. long, marked with brown cells, with velum lacking; megaspores ashy or light brown when dry, dark shining brown when wet, 600–800 μ in diameter, marked with small distant tubercles, rarely elongated in one diameter, or somewhat ridge-like; microspores brown, 29–36 μ long, chiefly spinulose.

Distribution: Tasmania, mountain lakes.

Specimens examined:

Tasmania: Lake Fenton, Mt. Field, 3000 ft. alt., 1869, *v. Mueller* (N. Y. Bot. Gard. Herb.); Mt. Field, *Rodway* (Mo. Bot. Gard. Herb.); Hartz Mts., 1918, *Rodway* (Mo. Bot. Gard. Herb.); Hobart, 1918, *Rodway* (Mo. Bot. Gard. Herb.).

In this short coarse plant, the upper half of the leaves usually appears a dark green, the base brown, in herbarium specimens. The bulb formed by the sporangia is apt to be 3–4 cm. in diameter. According to F. v. Mueller, the leaves are rigid enough so that the term "water-porcupine" seemed fitting for plants growing in Lake Fenton on Mt. Field. He reported corms as large as one's fist, and a habit of growth in groups that resulted in a polster.

All of the material examined at Mo. Bot. Gard. in 1918 was obtained through the courtesy of L. Rodway of Hobart, Tasmania, who is presumably the collector.

20. I. Drummondii A. Br. Monatsber. K. Akad. Wiss. Berlin, 593. 1863, and 542. 1868; Baker, Jour. Bot. **18**: 70. 1880, and Fern Allies, 128. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 319. *pl. 13. fig. 4–5.* 1883.

Calamaria Drummondii Kuntze, Rev. Gen. Pl. **2**: 828. 1891-93.

Corm 3-lobed; leaves 18 or fewer, 3–7 cm. long, somewhat loosely arranged, coarser than *I. Muellerii* and *I. tripus,* bright green; stomata present; no peripheral strands; ligule very short, cordate-triangular; sporangium rounded, without sclerenchyma cells; velum lacking; megaspores whitish when dry, dark brown when wet, 340–470 μ in diameter, marked with numerous (36–40) minute tubercles, distinct on apical faces, sometimes confluent in meandriniform ridges on basal face; microspores 30–39 μ long, violet-ashy, short denticulate-muricate.

Distribution: Australia: Swan River.

Specimens examined:

Australia: wet rocks, Toodyay, coll. *O. W. F.* (N. Y. Bot. Gard. Herb.); Tea Tree Gully, South Australia, 13 October, 1917, *Osborn* (Mo. Bot. Gard. Herb.); National Park, Belair, 27 September, 1917, *Osborn* (Mo. Bot. Gard. Herb.); Echunga, South Australia, 1 September, 1921, *Osborn* (Mo. Bot. Gard. Herb.).

The plants of the first collection were small, consisting of 5 or 6 fine leaves, about 3 cm. long, bearing sporangia 2–2.5 mm. in length, without velum. The megaspores were 360–470 μ in diameter, chiefly 430 μ, and showed rather close anastomosing ridges on basal face. The microspores, densely spinulose, 32–39 μ in length, were brown in the mass, with a violet cast.

21. I. amazonica A. Br. acc. Kuhn in Martius, Fl. Bras. 1^2: 647. *pl. 79. fig. 5–6.* 1884; Baker, Jour. Bot. **18**: 109. 1880, and Fern Allies, 133. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 351. 1883.

Calamaria amazonica Kuntze, Rev. Gen. Pl. **2**: 828. 1891-93.

Corm 3-lobed; leaves 10–12, 5–7 cm. long, somewhat rigid; stomata and accessory peripheral strands present; ligule short, triangular; sporangium small (2–2.5 mm.), lacking velum; megaspores white to ashy, 430–510 μ in diameter, with numerous warts, single or confluent into verrucose ridges; microspores 33–40 μ, finely tuberculate.

Distribution: Brazil.

Specimens examined:

Brazil: near Santarem, Para, September, 1850, *Spruce* (Gray Herb.), TYPE?

In the Mo. Bot. Gard. Herb., there are some immature specimens from "ditches of the Agulhas Negras, Serra do Itatiaia, State of Santa Catharina, Brazil, Rio de Janeiro, March, 1894. E. Ule." These consist of 4 or 5 leaves, 2–3 cm. in length, rather soft, light green, with fairly numerous stomata and no evident peripheral strands. There is fragmentary material of megaspores, almost smooth or lightly marked with wavy prominences; the diameter appears to be 400–468 μ. The microspores, 23–27 μ long, are smooth or with minute tubercles. The form was placed by Eaton in *I. amazonica*. Such fragmentary, doubtfully mature material is difficult to place with certainty. The geographic range is great if this form occurs in these two states at opposite ends of Brazil in different river systems.

Quite different specimens of Dusen's collecting from the same station seem to accord better with *I. Martii* A. Br., though again the spores are immature.

22. **I. Gardneriana** A. Br. Verh. Bot. Ver. Brandenb 4: 330. 1862; Mett. Fil. Lechl. Fasc. 11: 36; Kuhn in Martius, Fl. Bras. 1²: 647. *pl. 79. fig. 1–4.* 1884; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 349. 1883; Baker, Jour. Bot. 18: 110. 1880.

Calamaria Gardneriana Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed, 3–3.5 cm. broad; leaves erect, coarse, firm, 30–32 cm. long, attenuate at apex, somewhat obtuse, obscurely quadrangular; peripheral strands 4, strong; stomata present; ligule triangular, obtuse, hardly half as long as the sporangium; velum incomplete; sporangium dark, about 10 mm. long; megaspores 540–700 μ in diameter, dark brown whether wet or dry, with number of fine tubercles, distinct on all faces; microspores very smooth, white, 35 μ in length.

Distribution: Province of Goyaz in Brazil; Paraguay.

Description from Braun and Kuhn.

23. **I. elatior** F. Muell. in A. Br. Linnaea 25: 722. 1852, and Monatsber. K. Akad. Wiss. Berlin, 536. 1868; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 348. 1883.

Isoetes tasmanica F. Muell. in Dur. Bull. Soc. Bot. Fr. **11**: 104. 1864.

Calamaria elatior Kuntze, Rev. Gen. Pl. **2**: 828. 1891-93.

Corm 3-lobed; leaves numerous and long, flexuous; stomata and peripheral strands lacking; ligule cordate, elongated; sporangia dark, practically black with sclerenchyma cells; velum lacking; megaspores white when dry, black when moist, 480–650 μ in diameter, marked with minute, very dense tubercles all over surface, confluent into ridges; microspores coffee-brown, (28) 32–35 μ in length, densely muricate.

Distribution: Tasmania.

Specimen examined:

Tasmania: *Archer* (Gray Herb.).

This sheet is marked "*I. lacustris*. Tasmania. Coll. R. C. Gunn." to which Engelmann, Feb. 1880, made note, "Not collected by Gunn. Identical with *I. elatior* F. Muell. *Archer* legit."

The megaspores are 570–650 μ in diameter, with minute elevations above, crinkly in effect, but not anastomosing on the basal face. The microspores range from 28 to 34 μ, and are covered with numerous fine spines. The leaves are 14–18 in number, about 30 cm. long, and lack a velum.

Description in part from Braun.

24. I. Muelleri A. Br. Monatsber. K. Akad. Wiss. Berlin, 541. 1868; Baker, Jour. Bot. **18**: 69. 1880, and Fern Allies, 127. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 389. 1883.

I. tenuissima F. Muell. (non Boreau) Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 389. 1883.

Calamaria Muelleri O. K. Rev. Gen. Pl. **2**: 828. 1891-93.

Corm 3-lobed, with loose bulb of leaves; leaves few, 7 cm. long, narrow, attenuate, pale green, diaphanous; stomata present; peripheral strands lacking; ligule cordate-ovate; velum complete, closed, pale; sporangium becoming dark, with all epidermal cells thickened, some light, some very dark; megaspores 330–390 μ, white or ashy white, marked with less numerous (20–25 tubercles per face) unequal tubercles, even confluent into branching ridges.

Distribution: Eastern Australia, wet places at Rockhampton.

25. **I. histrix** Bory & Dur. Compt. Rend. Acad. Paris **18**: 1167. 1844; A. Br. in Bory & Dur. Expl. Sci. Alg. 36. *fig. 1.* 1846-49; Milde, Fil. Eur. 288. 1867; Kuhn, Fil. Afr. 195. 1868; Baker, Jour. Bot. **18**: 110. 1880, and Fern Allies, 134. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 394. 1883.

Calamaria Hystrix Kuntze, Rev. Gen. Pl. 2:828. 1891-93.

I. Delalandei Lloyd, Fl. Ouest. Fr., ed. 1, 728. 1854.

Cephaloceratodon hystrix Genn. Comment. Critt. Ital. (3): 111. 1862.

Corm 3-lobed; leaves 9–22, 5–10 cm. long, linear, firm, with membranaceous margin disappearing at sporangium level; bases of leaves persistent as hard brown horny structures, with central short broad tooth and two longer lateral spine-like teeth, producing an exaggerated effect of size at the corm level through persistence from one season through succeeding ones; stomata numerous; peripheral strands 4, strongly developed; ligule ovate-triangular; sporangia 4–6 mm. long, completely covered by velum; megaspores white, 400–560 (600) μ in diameter, closely marked with small tubercles or warts, becoming somewhat confluent, especially on the basal surface; microspores brown, 25–33 μ long, spinulose.

Distribution: Algeria, islands of Mediterranean, Italy, France.

Specimens examined:

Algeria: dry sands, hills of LaCalle, March, 1841, *Durieu* (Mo. Bot. Gard. Herb.), TYPE; dry hills, LaCalle, 30 March, 1841, *Durieu* (Gray Herb.); near Mascara, May, 1844, *Bory* (Gray Herb.); Mascara, May, 1841, *Durieu* (Mo. Bot. Gard. Herb.); near Mascara, 14 September, 1864, *Warion* (U. S. Nat. Herb.); "Telegraph, infer Alger," April, 1856, *Guthnik?* (N. Y. Bot. Gard. Herb.); in wet sandy places at Sidi-Dako, near Mascara, 28 April, 1875, *Warion Pl. Atl. Sel. 187 (Kralik)* (U. S. Nat. Herb. and Gray Herb.); wet sands of the plain of Chearfa, Mostaganem, Prov. Oran, 19 May, 1875, *Cosson* (Gray Herb.); Dj. Ouach. Prov. Constantine, 26 May, 1880, *Cosson* (Gray Herb.); LaCalle, April, 1884, *Debeaux* (U. S. Nat. Herb.); Bône, 1906, *Gandoger* (Mo. Bot. Gard. Herb.).

Tunis: north of Aïn-Draham, 4 July, 1883, *Cosson et al.* (Gray Herb.).

Corsica: Bonifacio, 21 April, 1866, *Mabille* (Mo. Bot. Gard.

Herb.); Porto Vecchio, April and May, *Revelière* (U. S. Nat. Herb. and N. Y. Bot. Gard. Herb.).

Phrygia: dry hills near village Kaiageul, S. of Ouchak, 30 May, 1857, *Balansa 849* (U. S. Nat. Herb.).

Crete: Crete, 12 March, 1882, *Reverchon* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Crete, *ex herb. Ball* (Gray Herb.).

Sardinia: Caprera I., granitic soil, 15 May, 1905, *Vaccari 503* (Gray Herb.); Bancamino, 3 June, 1881, *Reverchon* (N. Y. Bot. Gard. Herb.).

Italy: Castagnolo, 3 May, 1865, *Caruel* (Mo. Bot. Gard. Herb.); wet fields, Castagnolo, Pisa, 28 November, 1862, *Ball* (Gray Herb.).

France: Isle d'Yeu, Vendée, May, 1880, *Grand-Marais* (N. Y. Bot. Gard. Herb.); near the sea coast on Isle d'Yeu, Vendée, May, 1883, *Grand-Marais* (Mo. Bot. Gard. Herb.); "mare de Rochaute," near Agde, 5 October, 1846, *Fabre* (Gray Herb.); Ile de Houat, Morbihan, April, 1853, *Lloyd 198* (N. Y. Bot. Gard. Herb.).

25a. Forma subinermis Dur. Bull. Soc. Bot. Fr. 8: 164. 1861.

I. histrix f. *desquamata* A. Br. Monatsber. K. Akad. Wiss. Berlin, 617. 1864.

I. hystrix Wolsey, New Phytol. II. 5: 45. 1861.

Cephaloceratodon gymnocarpum Genn. Comment. Critt. Ital. (3): 113. 1862.

I. histrix var. *scutellata* A. Br. acc. Motel. & Vendr. Actes Soc. Linn. Bord. 36: 400. 1883.

The form differs from the species in the persistent structure resulting from the leaf base; the former lacks the lateral horns or teeth. There is a wider range in megaspore size, with a slight tendency toward greater size, and the confluence of the tubercles is sometimes quite pronounced.

Phrygia: rocky hills above the village of Kaiageul, s. of Ouchak, 30 May, 1857, *Balansa 1327* (Gray Herb.).

Sardinia: near Pula, at foot of Mt. Santo, in wet declinities, inundated in winter, alt. 30 m., granitic soil, 23 March, 1912, *Fiori & Béguinot 1607* (Gray Herb.); I. Caprera, July, 1863, *Ascherson & Reinhardt* (Mo. Bot. Gard. Herb.); I. of Caprera, 11 June, 1863, *Ascherson & Reinhardt* (Gray Herb.).

France: near Cazau (Landes), 5 July, 1861, *ex herb. norm. F. Schultz* (*Durieu*) *781* (U. S. Nat. Herb.); "southern France," July, 1861, *Durieu* (Gray Herb. and N. Y. Bot. Gard. Herb.); near Grasse, Alpes Maritimes, 1 April, 1891, *Mouillefarines* (U. S. Nat. Herb.); pools near Cazau, Landes, 29 June, 1862, *Durieu* (Mo. Bot. Gard. Herb.); sandy pastures near Étang and village of Cazau, Landes, 1861, *Durieu* (Mo. Bot. Gard. Herb.); dry sand near Cazau, September, 1861, *Durieu* (Gray Herb.); near the sea-coast, on the Ile d'Yeu Vendée, May, 1883, *Grand-Marais* (Mo. Bot. Gard. Herb.); Gironde, August, 1891, *Motelay* (Mo. Bot. Gard. Herb.); Cazau (Gironde), along railroad near station of Cazau, Hameau, 20 May, 1900, *Neyraut* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); Mios, Gironde, 11 July, 1897, *Neyraut* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.).

Guernsey: L'Aucresse, 15 June, 1884, *Hanbury 1656* (N. Y. Bot. Gard. Herb.).

The plants of Neyraut collected at Mios are unusual in large number of leaves (up to 50), but appear to be the form with a poor development of the scaly bases.

26. I. Nuttallii A. Br. in Engelm. Am. Nat. 8: 215. 1874; Baker, Jour. Bot. 18: 105. 1880; Engelmann, Trans. St. Louis Acad. Sci. 4: 388. 1882; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 375. 1883; Macoun, Cat. Canad. Pl. pt. 4: 293. 1888; Piper, Contr. U. S. Nat. Herb. 11: 88. 1906.

I. opaca Nuttall in Engelm. Trans. St. Louis Acad. Sci. 4: 388. 1882.

I. Suksdorfii Baker, Fern Allies, 132. 1887.

Calamaria Nuttallii Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm slightly 3-lobed; leaves 13–60, 8–17 cm. long, 3-angled, very slender, firm, erect, light green, with membranaceous margins not extended beyond sporangium level; stomata numerous; peripheral strands 3 (sometimes 2 dorsal lacking); ligule small, triangular; sporangia oblong, 4–7 mm. long, completely covered by velum; megaspores white, (320) 400–528 (600) μ in diameter, densely covered by small, usually glistening, distinct papillae on faces between prominent commissural ridges, or rarely smooth; microspores brown, 25–30 μ in length, papillose.

Distribution: California, Oregon, Washington, Vancouver.

Specimens examined:

California: Mt. Tamalpais, Marin Co., 13 June, 1892, *Palmer 2355* (U. S. Nat. Herb.); Tamalpais, June, 1891, *Brandegee* (N. Y. Bot. Gard. Herb.); Mt. Tamalpais, Marin Co., 13 June, 1892, *Mrs. Brandegee* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); Mt. Tamalpais, Marin Co., near the big spring on trail to Larsens, 28 June, 1896, *Miss Eastwood* (Mo. Bot. Gard. Herb.); Pine Ridge, Fresno Co., 25 May, 1901, *Thompson* (Mo. Bot. Gard. Herb.); Soquel Point, between Santa Cruz and Capitola, 28 May, 1902, *Mrs. C. H. Thompson* (Mo. Bot. Gard. Herb.); Soquel Point, Santa Cruz, summer, 1903, *Thompson* (Mo. Bot. Gard. Herb.); San Diego, 6 March, 1895, *Brandegee* (Mo. Bot. Gard. Herb.); Glacier Point Meadows, edges of pools in black mucky soil, alt. 7100 ft. (Canadian Life Zone), 6 July, 1914, *Smiley 492* (Gray Herb.); Tuolumne Meadows, pools back of Muir Lodge, Yosemite, alt. 8500 ft. (Canadian Life Zone), 13 August, 1916, *Smiley 747* (Gray Herb.); Coste Madera, June, 1887, *Curran* (N. Y. Bot. Gard. Herb.); partially submerged in sluggish stream, Williams Ranch, Tuolumne Co., 14 June, 1895, *Blasdale* (N. Y. Bot. Gard. Herb.).

Oregon: low pondy places and on high banks in springy situations in Willamette Valley, Salem, Silverton, etc., June and July, 1871, *Hall 693* (Mo. Bot. Gard. Herb., Gray Herb. and U. S. Nat. Herb.); low grassy places, Oregon, 1871, *Hall* (Gray Herb.); "terrestrial, under scrub-oaks," Woodburn, 1 June, 1882, *Thos. J. Howell* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); on springy soil and in water near Milwaukee, July, 1880, *J. Howell & Thos. J. Howell 303* (Gray Herb.); on damp springy soil and in water, near Milwaukee, July, 1880, *J. Howell* (Gray Herb.); Oregon, 1886, *T. J. Howell 613* (Gray Herb.); Gladstone, 14 July, 1894, *T. J. Howell 1526* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Univ. Minn. Herb.); in shallow pool near south fall, Silver Creek Falls, Marion Co., 29 May, 1921, *Nelson* (*Peck*) *3737* (U. S. Nat. Herb.).

Washington: Columbia River 183-, *Nuttall* (Mo. Bot. Gard. Herb.), TYPE?; springs and meadows, W. Klickitat Co., May, August, 1881, *Suksdorf* (Mo. Bot. Gard. Herb. and U.

S. Nat. Herb.); springs and meadows, W. Klickitat Co., May and September, 1886, *Suksdorf* (N. Y. Bot. Gard. Herb.); meadows and springy places, Columbia River, 12 March and September, 1886, *Suksdorf 917* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); on damp ground, Falcon Valley, 16 June, 1890, *Suksdorf 2378* (Mo. Bot. Gard. Herb.); springy places near Bingen, W. Klickitat Co., 5 June, 1894, *Suksdorf 917* (Mo. Bot. Gard. Herb.); wet ground on mountain slopes near the Columbia River, W. Klickitat Co., 3 August, 1894, *Suksdorf 2364* (Mo. Bot. Gard. Herb.); on meadows, Falcon Valley, Klickitat Co., 17 July, 1896, *Suksdorf 2614* (Mo. Bot. Gard. Herb.); on low damp ground, Falcon Valley, W. Klickitat Co., 24 June, 1897, *Suksdorf 2615* (Mo. Bot. Gard. Herb.); on wet ground near Bingen, 14 April, 1904, *Suksdorf 4443* (Mo. Bot. Gard. Herb.).

Vancouver Island: Nanaimo, 13 July, 1887, *John Macoun 14219a, 14219c* (Gray Herb.); vicinity of Nanaimo, 3 July, 1908, *John Macoun 86378* (Gray Herb. and N. Y. Bot. Gard. Herb.); Nanaimo, *John Macoun* (Mo. Bot. Gard. Herb.); vicinity of Victoria, 10 June, 1893, *John Macoun 533* (Gray Herb.).

The peripheral strands are usually three in number at the angles of the 3-sided stem; of these three, the dorsal are the weakest, and in some cases, fail to appear. There is variation as to persistence of bases of leaves. Many specimens show dark brown horny bases (as long as the sporangium) surmounted by three minute teeth, of which the central is slightly longer than the lateral ones. There is variation in the megaspore character in that, though most are rather evidently marked, some are almost smooth.

27. **I. Orcuttii** Eaton, Fern Bull. 8: 13. 1900.

I. Nuttallii var. *Orcuttii* Clute, Fern Allies, 253. 1905.

Corm slightly 3-lobed; leaves 6–14 (or even 20), 2–6.5, rarely 10, cm. long, fine, erect, triangular, with narrow membranaceous margin only at base; stomata present; peripheral strands none or 2, weakly developed; ligule triangular; sporangia orbicular to slightly elongated, 2–5 mm. long, completely covered by velum; megaspores gray at maturity, brownish when wet, 216–360 μ, rarely 480 μ, in diameter, closely marked with numerous small

indistinct papillae or almost smooth, glistening; microspores 21–27 μ, rarely 29 μ, in length, chiefly spinulose, sometimes smooth.

Distribution: California, Lower California.

Specimens examined:

California: mesas in low depressions, San Diego, 7 June, 1884, *Orcutt 1242* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.), TYPE; 3 mi. northeast of Clovis, Fresno Co., 16 February, 1902, *Mr. & Mrs. C. H. Thompson* (Mo. Bot. Gard. Herb.); meadow, Soquel Point, Santa Cruz, 10 and 29 April, 1900, *C. H. Thompson* (Mo. Bot. Gard. Herb.); Soquel Point near Capitola, Santa Cruz Co., 6 March, 1901, *Mrs. C. H. Thompson* (Mo. Bot. Gard. Herb.); El Cajon, April, 1895, *Brandegee* (Mo. Bot. Gard. Herb.); 5 mi. west of Stanford University, near Los Francos Creek, 13 April, 1903, *Thompson* (Mo. Bot. Gard. Herb.); near Upland, growing in desiccating pools on clay mesa, 8 March, 1917, *Ivan Johnson* (U. S. Nat. Herb.); mesas, San Diego Co., 14 May, 1903, *Orcutt* (U. S. Nat. Herb.); in "Hog Wallows, dry as early as 10 March, usually wet until May 1," 1889, *Curran* (N. Y. Bot. Gard. Herb.); Antioch, Contra Costa Co., 7 April, 1895, *Burtt Davy* (N. Y. Bot. Gard. Herb.).

Lower California: near Santo Tomas, 12 April, 1886, *Orcutt* (Mo. Bot. Gard. Herb.).

This form differs from *I. Nuttallii* A. Br. chiefly in the smaller plants, both in length and number of leaves, and in the smaller size of the spores. The largest megaspores of *I. Orcuttii* are in the range of the smallest of *I. Nuttallii*. There is also a difference in the peripheral strands in that *I. Nuttallii* usually has three, of which the weakest or dorsal sometimes fails to develop. In *I. Orcuttii*, no such strands appear in the various leaves I have examined, though A. A. Eaton reported the presence of two weak groups of cells, a dorsal and ventral. Brandegee's material from San Diego combines megaspores with prominent markings that plainly fall in the range of *I. Nuttallii* (364–448 μ), sporangia larger than those of *I. Orcuttii*, but leaves the length of the latter (2.5–3 cm.), with no peripheral strands. Since it is believed that the leaf characters are more subject to ecological factors, these are here given less weight, and this specimen is

placed at present with *I. Nuttallii,* rather than with *I. Orcuttii,* with which Eaton placed it.

These two species are very close to each other, and with further evidence *I. Orcuttii* may prove a variety of *I. Nuttallii.*

28. I. humilior A. Br. Linnaea 25: 722. 1852.

I. Hookeri A. Br. Monatsber. K. Akad. Wiss. Berlin, 538. 1868; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 340. 1883.

Calamaria humilior Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

I. Stuartii A. Br. Monatsber. K. Akad. Wiss. Berlin, 539. 1868; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 339. 1883.

Corm compressed, 2-lobed; leaves somewhat coarse, rigid, tough, attenuate toward apex, obtuse, with somewhat thick, dark epidermis; stomata lacking; ligule short, cordate triangular; velum complete; sporangium small; megaspores 650–770 μ in diameter, with many small, little elevated, sometimes confluent tubercles on all faces; microspores 30–32 μ long, very short denticulate-muricate.

Distribution: So. River Esk, Tasmania.

The characters on which Braun separated the species *I. Hookeri* from *I. Stuartii* (the two were originally included in the species *I. humilior* by him) hardly seem of more than ecological significance (as softness of leaves) or are within the range of variation in any species (as dark coloring at the base of the leaves). Further he used only one specimen on which to base *I. Stuartii.* It would seem to the writer who has only the description on which to base judgment that the relation between these two is closer than as adjacent species, and they are accordingly united in the original *I. humilior* A. Br.

29. I. melanospora Engelm. Trans. St. Louis Acad. Sci. 3: 395. 1877, and 4: 383. 1882; Baker, Jour. Bot. 18: 69. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 359. 1883; Chapman, Fl. Southern U. S., ed. 2, 672. 1889; Small, Fl. Southeastern U. S. 25. 1903.

Calamaria melanospora Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed; leaves 5–11, 2.5–7 cm. long, slender, tapering very gradually to apex, almost setaceous, light green, spreading; stomata present; peripheral strands none; ligule small, triangular; sporangium orbicular, 1–2 mm. long, completely covered by

velum; megaspores dark gray when dry, black when wet, 400–480 μ in diameter, with small rough warts sometimes extended into short narrow ridges, which rarely anastomose; commissural ridges thin and blade-like; microspores brown, 26–31 μ long, smoothish to papillose.

Distribution: Stone Mountain, Georgia.

Specimens examined:

Georgia: shallow ponds on the summit of Stone Mt., May, 1869, *Canby* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.), TYPE; St. Louis culture from Stone Mt. material, 13 August, 1875, *Engelmann*, (Mo. Bot. Gard. Herb.); top of Stone Mt., April, 1875, *Gray* (Gray Herb.); cultivated by *Engelmann* from young plantlets brought by A. Gray from Stone Mt., 28 September, 1875, *Engelmann* (Mo. Bot. Gard. Herb.); St. Louis culture (from roots brought from Stone Mt. in September, 1876), August, 1877, *Engelmann 1954* (Mo. Bot. Gard. Herb.); shallow depressions on summit of Stone Mt., 13 April, 1897, *ex Biltmore Herb. 4264* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); shallow depressions on summit of Little Stone Mt., 15 May, 1897, *Biltmore Herb. 4264 b* (Univ. Minn. Herb.); Stone Mt., 17 April, 1891, *Underwood* (U. S. Nat. Herb.); "matured in laboratory" (from Stone Mt., 17 April, 1891), August, 1891, *Underwood* (U. S. Nat. Herb.); "grown in laboratory until December, 1891," (from Stone Mt., 17 April, 1891), *Underwood* (U. S. Nat. Herb.); top of Stone Mt., De Kalb Co., 25 July, 1897, *Eggert* (Mo. Bot. Gard. Herb.); "grown from Eggert's plants," 1898, *ex Herb. Eaton* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.).

30. I. lithophila Pfeiffer, sp. nov.[1]

Corm 2-lobed, small; leaves 6–14 in number, 10–12 cm. long, slender but not filiform, flexuous; stomata numerous; peripheral strands variable, none or 3, weak; ligule very small, cordate triangular; sporangium 2.5–4 mm. long, orbicular to oblong, com-

[1] **I. lithophila** sp. nov. Cormus bilobatus, parvulus. Folia numero 6–14, longitudine 10–12 cm., gracilia, flexilia, stomatibus numerosis instructa, fibris peripheriicis destituta vel tribus invalidis instructa. Lingula parvula, cordato-triangulata. Sporangia longitudine 2.5–4 mm, orbiculata vel oblongata, velo completo. Macrosporae diam. 290–360 μ, madidae fuscescentes, siccae cineraceae, leves vel humilibus brevibus aliquantulum extentis jugis leviter ornatae. Microsporae coffeaceofuscae, longitudine 30–33 μ, distincte tuberculatae vel spinulosae.

pletely covered by velum; megaspores 290–360 μ in diameter, with prominent high, rather narrow, commissural ridges; surface of megaspores gray when dry, brown when wet, smooth or faintly marked with low, short or somewhat extended, usually distant ridges; microspores dark brown, chiefly 30–33 μ, high-tuberculate or spiny.

Distribution: Texas.

Specimen examined:

Texas: in shallow depression in granite on east slope of Granite Mt., 70 mi. northwest of Austin, 9 May, 1914, *McAllister* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.), TYPE.

31. I. flaccida Shuttlew. A. Br. Flora 29: 178. 1846; Am. Jour. 3: 2. 1847; Chapman, Fl. Southern U. S. 602. 1889; Engelm. Trans. St. Louis Acad. Sci. 4: 386. 1882.

I. flaccida var. *rigida* Engelm. Trans. St. Louis Acad. Sci. 4: 386. 1882.

I. flaccida var. *Chapmani* Engelm. Trans. St. Louis Acad. Sci. 4: 386. 1882.

I. Chapmani Small, Ferns of Florida, 133. 1918.

Calamaria flaccida Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed; leaves 8–40, 10–40 cm. long, slender, light green, sharp-pointed, with usually narrow, membranaceous margin; stomata numerous; peripheral strands 4; ligule short-triangular; sporangia oblong, 3–5 mm. long, completely covered by the velum; megaspores light, 300–500 μ in diameter, sometimes less; apical face rarely smooth, usually marked centrally with few large tubercles; basal face with bold, short, rounded ridges, sometimes anastomosing; microspores light brown, 26–33 μ long, slightly papillose.

Distribution: Georgia, Florida.

Specimens examined:

Georgia: in very shallow water or entirely emersed, in wet pine-barrens, Sumter Co., 5 July, 1901, *Harper 1010* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Gray Herb.); in sluggish pine-barren stream east of Douglas, Coffee Co., 19 July, 1902, *Harper 1429* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Gray Herb.).

Florida: Lake Immonia, north of Tallahassee, 1842-49, *Rugel* (Mo. Bot. Gard. Herb.), TYPE; marshes, Apalachicola, *Chap-*

man? (Mo. Bot. Gard. Herb.); lakelet of clear limestone water near Marianna, August, 1850, *Chapman* (Mo. Bot. Gard. Herb.); marshes, Apalachicola, 1890, *Herb. Chapman* (U. S. Nat. Herb.); Manatee, April, 1878, *Garber without number* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); same place and date, *Garber 2312* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); same, *Garber 32* (U. S. Nat. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.); open miry places in Turnbull Swamp, Halifax River, May, *Curtiss 3813* (U. S. Nat. Herb.); Lake Flirt, August, 1878, *Garber* (Mo. Bot. Gard. Herb.).

31a. Var. **alata** (Small) Pfeiffer, var. nov.

I. alata Small, Ferns of Florida, 133. 1918.

Similar to the species in stature and leaf characters, but differing in spore markings; upper faces usually crowded with tubercles, which may become ridge-like; lower face with bold rounded ridges so anastomosing as to give more or less irregularly reticulate effect; spore range is about the same, 290–540 μ as extremes, with 430–540 μ most commonly occurring. A form in which the megaspores are usually larger (430–540 μ) and the microspores in the higher range of 30–33 μ, then showing spines quite readily, might be distinguished (*Eaton 832* and *837, Curtiss 3813*, Mo. Bot. Gard. Herb.).

Distribution: Georgia, Florida.

Specimens examined:

Georgia: in sluggish pine-barren stream, Bulloch Co., partly emersed, 10 June, 1901, *Harper 843* (U. S. Nat. Herb.); in sluggish pine-barren stream, partly emersed, Bulloch Co., 26 June, 1901, *Harper 951* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., Gray Herb., and N. Y. Bot. Gard. Herb.); in cypress pond near Cobb, Sumter Co., 11 July, 1901, *Harper 1046* (Mo. Bot. Gard. Herb., Gray Herb., U. S. Nat. Herb., and N. Y. Bot. Gard. Herb.).

Florida: open miry places in Turnbull Swamp, Halifax River, May, *Curtiss 3813* (Mo Bot. Gard. Herb.); margin of shaded pond, Riverland, Sumter Co., 23 July, 1900, *Curtiss 6696* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); Miami River and Everglades, Dade Co., 17 November, 1903, *Eaton*

337 (Mo. Bot. Gard. Herb.); muddy alligator hole at Gossman's, Dade Co., 25 February, 1905, *Eaton 1244* (Mo. Bot. Gard. Herb.); Fort Ogden, De Soto Co., 31 March, 1905, *Eaton 1455* (Mo. Bot. Gard. Herb.); without locality or date, *Eaton 832* (Mo. Bot. Gard. Herb.).

The characteristic on which Small named the species *I. alata,* namely, prominent wings in the lower parts of the leaves, is apt to be found in any large-bulbed form, where the leaf bases become broad. In regard to the spore markings, it is possible to find transitional material (*Harper 1046*).

32. I. Lechleri Mett. Fil. Lechler. 2: 36. 1859; A. Br. Verh. Bot. Ver. Brandenb. 4: 331. 1862; Baker. Jour. Bot. 18: 68. 1880, and Fern Allies, 126. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 357. *pl. 15. fig. 1–2.* 1883.

Calamaria Lechleri Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

I. socia A. Br. Verh. Bot. Ver. Brandenb. 4: 332. 1862.

I. Karstenii A. Br. Verh. Bot. Ver. Brandenb. 4: 332. 1862.

Corm 2-lobed; leaves 5–15, 4 cm. long, medium fine, tapering to point, from base widened by membranous sheath; peripheral strands none; stomata fairly numerous; sporangia 3–4 mm. long; velum complete; megaspores white, 380–440 μ in diameter, with roughened surface, marked by very low tuberculate and serpentine elevations; microspores ashy brown, 30–36 μ long, markedly spinulose.

Distribution: Argentina.

Specimen examined:

Argentina: Province of Cordoba, 2 February, 1887, *Hieronymus 774* (U. S. Nat. Herb.).

This specimen is labeled by Hieronymus as *I. socia* A. Br., which is but a form of *I. Lechleri* Mett. according to Braun, who at the same time described *I. Karstenii,* which seems to fit this plant a little better because of spinulose microspores. Braun reduced both species to *I. Lechleri,* widening its range.

33. I. triquetra A. Br. Verh. Bot. Ver. Brandenb. 4: 332. 1862; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 325. 1883.

Calamaria triquetra Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

I. Andina Spruce in Motel. & Vendr. Actes Soc. Linn. Bord.

36: 325. 1883.

Corm 2-lobed; leaves 6–100, coarse, erect, form abruptly pointed, triangular in cross-section; stomata and peripheral strands lacking; sporangia oblong, truncate, hardly spotted; velum lacking; megaspores inconspicuously tuberculate above, distinctly in center of basal part; microspores smooth, brown or white.

Distribution: South America, Peru.

This description is derived from a combination of characters given by A. Braun and Motelay & Vendryès.

34. I. Howellii Engelm. Trans. St. Louis Acad. Sci. 4: 385. 1882; Underwood, Native Ferns and Fern Allies, 124. 1882; Eaton, Fern Bull. 8: 32–33. 1900; Piper and Beattie, Fl. Wash. 8. 1914.

I. nuda Engelm. Trans. St. Louis Acad. Sci. 4: 385. 1882.

I. Underwoodi Hend. Bot. Gaz. 23: 124. 1897.

I. melanopoda var. *californica* A. A. Eaton in Gilbert, List N. Am. Pterid. 10: 27. 1901.

Corm 2-lobed; leaves 10–30, rarely 50, 5–24 cm. long, bright green, erect or slightly outspread, slender (less so in emersed forms), with wide membranaceous margin extending 1–5 cm. above sporangium level, sometimes abruptly narrowed; stomata numerous; peripheral strands usually 4, sometimes 1 or more lacking; ligule narrow, elongated triangular; sporangia orbicular to oblong, 3–6, rarely 8, mm. long, frequently brown-spotted, partially covered by velum, up to 1/3; megaspores white, 420–520 μ in diameter, more or less obscurely marked with simple tubercles to short crests, isolated or anastomosing, sometimes crowded, sometimes distant; microspores 25–33 μ long, chiefly 27 μ, smoothish to short spinulose.

Distribution: W. Montana, Idaho, Washington, Oregon, California.

Specimens examined:

Montana: 3000 ft. alt., Bigfork, Flathead Co., 14 August, 1909, *Jones* (Mo. Bot. Gard. Herb.); border of Swan Lake, 15 August, 1901, *Umbach* (U. S. Nat. Herb.).

Idaho: in wet places along Paradise Creek, Moscow, 11 June, 1895, *Henderson 2894* (U. S. Nat. Herb.); wet ground about pools, Paradise Creek, Moscow, without date, *Henderson*

(N. Y. Bot. Gard. Herb.); low soil, forks of St. Mary's River, alt. 1000 m., 3 July, 1895, *Leiberg 1149* (U. S. Nat. Herb.); growing in water, pools near Moscow, but maturing macrospores and microspores in mud, 24 June, 1897 and 30 July, 1898, *Henderson* (Gray Herb.); about forest, Nez Perces Co., alt. 3500 ft., 30 July, 1896, *A. A. & E. Gertrude Heller 3482* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Univ. Minn. Herb.); in mud, Warrens Meadows, Eastern Latah Co., 2 July, 1898, *Henderson 2978* (Mo. Bot. Gard. Herb.); in water or mud, Moscow, 24 June and 2 August, 1898, *Henderson* (Mo. Bot. Gard. Herb.); Moscow, 30 May, 1897, *Henderson 2894* (Mo. Bot. Gard. Herb.); wet shores, Lake Coeur d'Alene, alt. 650 m., 1 October, 1895, *Leiberg 1656* (U. S. Nat. Herb.); wet shores of Lake Pend d'Oreille, alt. 650 m., 2 October, 1895, *Leiberg 1663* (U. S. Nat. Herb.); lake shore, Sand Point, 24 August, 1901, *Umbach* (U. S. Nat. Herb.).

Washington: near Spangle, Spokane Co., 28 June, 1884, *Suksdorf 2369* (Mo. Bot. Gard. Herb.); in slow shallow stream, Falcon Valley, 30 July, 1885, *Suksdorf 833* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); in slow shallow stream, Falcon Valley, 6 September, 1886, *Suksdorf 2370* (Mo. Bot. Gard. Herb.); in mud in shallow water, becoming dry in summer, Spokane Co., 10 June and 11 July, 1889, *Suksdorf 950* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Rock Creek, near Mica Peak, Spokane Co., 5 June, 1889, *Suksdorf 2368* (Mo. Bot. Gard. Herb.); near Rockland, Klickitat Co., 15 April, 1890, *Suksdorf 1235* (Mo. Bot. Gard. Herb.); in a ditch, Falcon Valley, 30 July and 16 October, 1895, *Suksdorf 2372* (Mo. Bot. Gard. Herb.); Falcon Valley, Klickitat Co., 16 July, 1896, *Suksdorf 2613* (Mo. Bot. Gard. Herb.); in shallow water, Falcon Valley, 16 July, 1896, *Suksdorf 2479* (Mo. Bot. Gard. Herb.); Falcon Valley, 28 June, 1898, *Suksdorf 2616* (Mo. Bot. Gard. Herb.); Rockland, Klickitat Co., 10 May, 1899, *Suksdorf 2618* (Mo. Bot. Gard. Herb.); muddy banks of Pend d'Oreille River near Cusick, 21 September, 1903, *Piper 4209* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.).

Oregon: on the borders of ponds, The Dalles, 1 June and 1 August, 1880, *J. & T. J. Howell* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.), TYPE; The Dalles, October, 1880, *T. J.*

Howell (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); The Dalles of the Columbia, 11 October, 1881, *Pringle* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Hood River, May, 1882, *T. J. Howell* (N. Y. Bot. Gard. Herb.); The Dalles, in small ponds, 20 May, 1882, *T. J. Howell* (Mo. Bot. Gard. Herb.); shallow pond 14 miles below The Dalles, 21 May, 1882, *T. J. Howell* (Mo. Bot. Gard. Herb.); nearly submerged in small ponds, Hood River, 22 May, 1882, *T. J. Howell* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Hood River, 3 July, 1891, *T. J. Howell 1521* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Univ. Minn. Herb.); in small ponds at The Dalles, May, 1895, *T. J. Howell 698* (Mo. Bot. Gard. Herb.); near Dalles City, 4 May, 1898, *Suksdorf 3017* (Mo. Bot. Gard. Herb.); in or near shallow water near Dalles City, Wasco Co., 7 June, 1904, *Suksdorf 642* (Mo. Bot. Gard. Herb.); shallow water on shore of Rogue River, near Solitude Bar, 26 June, 1917, *Nelson 1531* (Gray Herb.); completely submerged in standing water along S. P. tracks, 3 mi. south of Salem, 27 June, 1921, *Nelson 3989* (Mo. Bot. Gard. Herb.); bottom of dried-up pool, along S. P. tracks, 3 mi. south of Salem, 16 July, 1921, *Nelson 4059* (Mo. Bot. Gard. Herb.).

California: in shallow water, gravel, submerged, growing singly, Bear Valley, San Bernardino Mt., alt. 7000 ft., August, 1882, *S. B. & W. F. Parish 1440* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); in dry beds of shallow ponds, Olema, June, 1886, *Curran* (Mo. Bot. Gard. Herb.); Priest Valley, Monterey Co., 13 May, 1893, *Miss Eastwood* (Mo. Bot. Gard. Herb.); El Cajon, April, 1895, *Brandegee* (Mo. Bot. Gard. Herb.); on sand meadow, elev. 9000 ft., south fork Kaweah River, Tulare Co., 1 August, 1895, *Dudley 1043* (Dudley Herb.); in a pond, near Hyampom, Trinity Co., 10 June, 1896, *Howe & Blasdale* (Mo. Bot. Gard. Herb.); growing wholly or partially submerged in pond near Hyampom, Trinity Co., 10 June, 1896, *Howe* (N. Y. Bot. Gard. Herb.); in a marsh about a mile from Olema, Marin Co., 4 July, 1896, *Miss Eastwood* (Mo. Bot. Gard. Herb., Gray Herb., U. S. Nat. Herb., Univ. Minn. Herb.); pools in the plains, Chapman's, Mariposa Co., 27 April, 1897, *Congdon 91* (Gray Herb.); Powder Mill Canyon, Santa Cruz, 25 May, 1900,

Thompson (Mo. Bot. Gard. Herb.); Powder Mill Canyon, Santa Cruz, 9 May, 1901, *Mrs. C. H. Thompson* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); in a winter pond hole, elev. 2000 ft., near Burnett Creek, Monterey Co., 4 April, 1901, *Dudley* (Mo. Bot. Gard. Herb.); Woodside Valley pond, San Mateo Co., 31 October, 1909, *Dudley* (Dudley Herb.); common locally in shallow edges of sloughs, Chico, Butte Co., 30 May, 1903, *Copeland 3281* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); Coal Mine Ridge Ponds, Santa Cruz Mountains, 28 May, 1906, *McMurphy* (U. S. Nat. Herb.); edge of pond west of Scofield Pond, Coal Mine Ridge, 26 June, 1908, *Dudley* (Dudley Herb.); Coal Mine Ridge, 26 May, 1910, *Dudley* (Dudley Herb.); Coal Mine Ridge, San Mateo Co., 19 May, 1906, *McMurphy* (Dudley Herb.).

Lower California: Sierra El Taste, November, 1902, *Brandegee* (Mo. Bot. Gard. and U. S. Nat. Herb.).

The material collected by Brandegee at El Cajon, Cal., April, 1895, and at Sierra El Taste in November, 1902, is unusual for *I. Howellii* in the small spore size. The former has characteristic markings, has megaspores 360–400 μ in diameter (26–30 μ for microspores). The latter has megaspores 360–400 μ (26–30 μ for microspores), smoothish to lightly tuberculate, recalling somewhat *I. mexicana* but more nearly resembling *I. Howellii* in habit. Both are placed here provisionally, since the size of plant accords well and is too large for the var. *minima* with which the spore size would place these specimens.

Nelson's numbers 3939 and 4059 represent somewhat aberrant forms in the degree of development of the ridges on the megaspores, and in the long leaves (20–35 cm.), but they seem to fall within the range of *I. Howellii* rather than to be separable as a new form.

34a. Var. **minima** Pfeiffer, comb. nov.

I. minima Eaton, Fern Bull. 6: 30. 1898.

Corm 2-lobed; leaves 7–16, 3–6 (sometimes 8–10) cm. long, fine, somewhat spreading, attenuate at tip; stomata present; peripheral strands usually 4, weak; ligule triangular, slightly elongated; sporangium 2–3 mm. in length, about 1/3 covered by velum; megaspores white, 320–420 μ in diameter, marked

with vague short crests, tubercles, like species; microspores 23–30 μ, rarely 33 μ, in length, almost smooth to spinulose.

Distribution: Washington, California, Lower California.

Specimens examined:

Washington: in a slow shallow stream, Falcon Valley, 6 September, 1886, *Suksdorf 2371* (Mo. Bot. Gard. Herb.); damp places on prairies near Waverley, Spokane Co., 16 May, 1889, *Suksdorf 2365, 2366* (Mo. Bot. Gard. Herb.); on wet ground near Spangle, Spokane Co., May, 1889, *Suksdorf 2367* (Mo. Bot. Gard. Herb.).

California: San Diego, May, 1903, *Orcutt* (Mo. Bot. Gard. Herb. *not* U. S. Nat. Herb., same date and place).

Lower California: Sierra de la Laguna, 23 January, 1890, *Brandegee 674* (Gray Herb.).

The form differs from the type species in its smaller size, not only in leaf length and thickness, but also in megaspores and microspores.

A. A. Eaton founded his species *I. minima* on a 3-lobed specimen of this form. Since most of the material cited proves to be 2-lobed, it is supposed that the occurrence of 3 lobes is like the chance development reported occasionally in other regularly 2-lobed species.

35. **I. Bolanderi** Engelm. Am. Nat. 8: 214. 1874; Baker, Jour. Bot. 18: 68. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 338. 1883; Engelm. in Brewer & Watson, Bot. Cal. 2: 350. 1880; Coulter, Bot. Rocky Mts. 435. 1885; Engelm. Trans. St. Louis Acad. Sci. 4: 381. 1881; Macoun, Cat. Canad. Pl. pt. 4: 293. 1888; Piper, Contr. U. S. Nat. Herb. 9: 89. 1906; Coulter & Nelson, Bot. Rocky Mts. 25. 1909.

Calamaria Bolanderi Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

I. californica Engelm. in Gray, Manual, ed. 5, 677. 1867.

I. Bolanderi var. *Parryi* Engelm. Am. Nat. 8: 214. 1874.

I. Bolanderi Sonnei Hend. Bull. Torr. Bot. Club 27: 349. 1900.

Corm deeply 2-lobed; leaves 6–25, 6–13 cm. long, rarely 25 cm., slender, tapering to a very fine point, bright green, soft; stomata not numerous; peripheral strands usually lacking; ligule small, cordate; sporangia 3–4 mm. long, about 1/4–1/3 covered by velum; megaspores white, sometimes bluish, 300–440 μ, rarely

480 μ, in diameter, obscurely or more distinctly marked with low tubercles or wrinkles; microspores 23–30 μ long, more or less spinulose.

Distribution: Idaho, Wyoming, Colorado, Utah, Arizona, British Columbia, Washington, Oregon, California.

Specimens examined:

Idaho: Bitter Root Forest Reserve, alt. 2050 m., 26 August, 1897, *Leiberg 39* (Mo. Bot. Gard. Herb.); head of Bear Creek, Bitter Root Forest Reserve, alt. 2050 m., 26 August, 1897, *Leiberg 2939* (U. S. Nat. Herb.).

Wyoming: shallow pond near falls of Yellowstone River, 1873, *Parry 307* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.); Yellowstone Park, June, September, 1885, *Tweedy 417* (U. S. Nat. Herb.); ponds, Snake River, 9000 ft., August, 1897, *Tweedy 362* (N. Y. Bot. Gard. Herb.); Yellowstone Lake, 12 August, 1897, *Rydberg & E. A. Bessey 3520* (U. S. Nat. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.); Yellowstone Park, 4 August, 1902, *Mearns 2807* (U. S. Nat. Herb.); entirely submerged in shallow pond cut off from north end of Yellowstone Lake, 16 August, 1900, *C. E. Bessey 2* (N. Y. Bot. Gard. Herb.).

Colorado: ponds in Elk Mts., 1881, *Brandegee 2001* (Mo. Bot. Gard. Herb.); lake in Gunnison River Valley, 10,000 ft. alt., lakes near timber line, main range, Routt Co., September, 1891, *Trelease* (Mo. Bot. Gard. Herb.); (probably) submerged on coarse granite bottom, Ward, Boulder Co., alt. 2500 m., *Clokey* (*Schmoll*) *3986* (Mo. Bot. Gard. Herb.).

Utah: subalpine lake, Alta, Wasatch Mts., 12 August, 1879, *Jones* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Alta, Wasatch Mts., August, 1883, *Jones* (N. Y. Bot. Gard. Herb.).

Arizona: in a lake about 2 miles east of Tunnel Road, Black Mesa Forest Reserve, 1 June, 1900, *Coville 1053* (U. S. Nat. Herb.).

British Columbia: Indian Reservation, Kamloops, 29 June, 1889, *John Macoun 14212* (Gray Herb.); in 6 feet of water, Lake Mara, Sicamous, 7 July, 1889, *J. Macoun* (N. Y. Bot. Gard. Herb.).

Washington: ponds, alt. 6300 ft., Cascade Mts., August, 1882, *Tweedy* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.);

lakes of Cascade Mts., October, 1882, *Brandegee* (Mo. Bot. Gard. Herb.); ponds, Mt. Paddo (Adams), August, 31 October, 1881, *Suksdorf* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Mt. Adams, 12 August, 1882, *Thos. Howell* (N. Y. Bot. Gard. Herb.); Mt. Adams, alt. 6000 ft., 21 August, 1886, *Suksdorf 2375* (Mo. Bot. Gard. Herb.).

Oregon: Alpine, eastern Oregon, 1886, *Cusick 1451* (Gray Herb.); Gayhart Buttes, alt. 2250 m., 7 August, 1896, *Coville & Leiberg 271* (U. S. Nat. Herb.); in a pond, Flag Basin, Bear Creek watershed, Wallowa Mts., 9 September, 1907, *Coville 2483* (U. S. Nat. Herb.).

California: small lakes, Cisco, Sierra Nevada, June, 1870, *Bolander* (Mo. Bot. Gard. Herb.); near Mono trail, alt. 10,000 ft., 1866, *Bolander 5093* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Upper Tuolumne River, little pools, alt. 9000–10,000 ft., 1866, *Bolander 5091* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Mt. Dana, alt. 10,000 ft., 1866, *Bolander 5080* (Mo. Bot. Gard. Herb.); Mary's Lake, near summit, alt. 7000 ft., June, 1870, *Bolander* (Mo. Bot. Gard. Herb.); Ice Lake near Soda Spring station, Sierra Nevada, alt. 7500 ft., 11 October, 1880, *Engelmann* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); lakes, Summit Valley, alt. 7500 ft., 20–22 September, 1882, *Pringle* (Mo. Bot. Gard. Herb., Gray Herb., and N. Y. Bot. Gard. Herb.); Webber Lake, Sierra Co., *Lemmon* (Mo. Bot. Gard. Herb. and Gray Herb.); Lake Tahoe, May, 1889, *Lemmon* (Mo. Bot. Gard. Herb.); pond about 2 miles southwest of Whitney Meadows, Sierra Nevada, Tulare Co., 26 August, 1891, *Coville & Funston 1622* (N. Y. Bot. Gard. Herb. and U. S. Nat. Herb.); in pool on mountainside northwest of Whitney Meadows, Sierra Nevada, Tulare Co., 20 August, 1891, *Coville & Funston 1643* and *1650* (U. S. Nat. Herb.); same station, *Coville & Funston 1643* (Gray Herb. and N. Y. Bot. Gard. Herb.); about 4 miles northwest of Whitney Meadows, Sierra Nevada, Tulare Co., 25 August, 1891, *Coville & Funston 1691* (U. S. Nat. Herb. and N. Y. Bot. Gard. Herb.); Sierra Nevada, 1883, *Parry* (U. S. Nat. Herb.); Ice Lake (abandoned), Summit, Placer Co., 26 September, without year, *Kellogg* (U. S. Nat. Herb., N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb.); Donner Lake, September, 1887, *Curran* (Mo. Bot.

Gard. Herb. and U. S. Nat. Herb.): below Double Peak, Yosemite National Park, 6 August, 1919, *Clemens 2* (U. S. Nat. Herb.); above Dog Lake, Yosemite National Park, 30 July, 1919, *Clemens 1* (U. S. Nat. Herb.).

The varieties described have been placed with the type, since the characters distinguishing them seem either inconstant or not true morphological differences. Material from Yellowstone Lake, described as *I. Bolanderi* v. *Parryi* Engelm. falls well within the range of the type, except for shorter leaves than most other material. The variety *Sonnei*, distinguished by "shorter, more rigid leaves, apparent absence of stomata, almost orbicular macrosporangium, spotted with small dark spots, and its wide velum which covers from 1/3 to 2/3 of the sporangium," has not been available for study, but every point mentioned is the sort in which one anticipates variation within any Isoetes species. For this reason in addition to the similarity in locality, Donner Lake, Cal., from which specimens were examined that proved to be *I. Bolanderi*, the variety *Sonnei* is here reduced.

35a. Var. pygmaea Clute, Fern Allies, 228, 258. 1905.

I. pygmaea Engelm. Am. Nat. 8: 214. 1874.

Calamaria pygmaea Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm deeply 2-lobed; leaves few (5–15), 2–2.5 cm. long, stout, tapering but rather abruptly narrowed to the apex, with conspicuous membranous margins developed only to upper level of sporangium; stomata and peripheral strands lacking; ligule small, triangular; sporangium small, orbicular, partly covered by very narrow velum; megaspores white, 360–500 μ in diameter, smoothish or indistinctly marked with short wrinkles and tubercles, low and round in silhouette; microspores 26–30 μ, smooth to slightly papillose.

Distribution: Nevada, Arizona, California.

Specimens examined:

Nevada: floating in Walker Lake, brought down from Mono Pass above, 14 August, 1898, *Congdon 991* (Gray Herb.).

Arizona: Huachuca Mts., So. Arizona, *Lemmon* (Mo. Bot. Gard. Herb.).

California: Mono Pass, eastern declivity of Sierra Nevada, alt. 6000 ft., September, 1866, *Bolander 6095* (Mo. Bot. Gard.

Herb.), TYPE; Mono Pass, in deep water, *Bolander 6333* (U. S. Nat. Herb.).

There are two sheets of material, one with a single specimen, the other with two plants, in Mo. Bot. Gard. Herb., from Engelmann's herbarium. The appearance of the leaves is not at all that of *I. Bolanderi*, since they are very short and taper markedly from a wide margin occurring at the sporangium level, but the spore characters are very similar to *I. Bolanderi*. Additional material from U. S. Nat. Herb. shows the same stout leaves, with almost setaceous tips, and is probably from the same collection as the *type 6025*.

36. I. Tuerckheimii Brause in Urban, Symb. Antillanae 7: 161. 1912.

Corm 2-lobed; leaves 10–31, 5–10.5 cm. long, slender, gradually tapering to apex, with narrow membranaceous margin extending only to level of top of sporangium; stomata at tip of leaf; peripheral strands none; ligule short-triangular, cordate at base; sporangia globose to oblong, 3–4 mm. long, about 1/3 covered by velum; megaspores 410–500 μ in diameter, smooth or lightly marked with rather distant low warts; microspores 26–32 μ long, smooth.

Distribution: Haiti.

Specimens examined:

Haiti (St. Domingo); near Constanzo in Valle Nuevo, alt. 2200 m., in rock fissures in rivulet, August, 1910, *Türckheim 3531* (Mo. Bot. Gard. Herb., Gray Herb., N. Y. Bot. Gard. Herb., and U. S. Nat. Herb.). TYPE.

Of the available species *I. Tuerckheimii* seems to resemble in spore characters *I. mexicana* Underw. It differs in the lack of peripheral strands and in the very different habitat.

37. I. mexicana Underw. Bot. Gaz. 13: 93. 1888.

I. Montezumae Eaton, Fern Bull. 5: 25. 1897.

Corm 2-lobed; leaves 10–30, 7–23, or rarely 30, cm. long, fine, erect, tapering, with membranaceous margin 2–3 times length of the sporangium; stomata numerous; peripheral strands usually 4; ligule triangular, somewhat elongated; sporangia 3–6 or even 8 mm. long, with very narrow velum; megaspores white, 320–

460 μ, rarely larger, in diameter, sharply angular in outline, with faces smooth or marked with large low tubercles; microspores fawn-colored, chiefly 27–39 μ long, mostly spinulose.

Distribution: Chihuahua, Hidalgo, Mexico, Morelos.

Specimens examined:

Mexico: wet places, pine plains, base of Sierra Madre, State of Chihuahua, 6 October, 1887, *Pringle 1447* (U. S. Nat. Herb. and Gray Herb.), TYPE; wet places, base of Sierra Madre, 10 October, 1888, *Pringle 1713* (Mo. Bot. Gard. Herb.); Canales Station, State of Hidalgo, 29 September, 1904, *Pringle 8796* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); wet soil, borders of shallow ponds, plains near Flor de Maria, State of Mexico, 28 August, 1890, *Pringle 3459* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); shallow pools, Sierra de las Cruces, alt. 9500 ft., State of Mexico, 24 August, 1904, *Pringle 13261* (U. S. Nat. Herb. and Gray Herb.); shallow water near Cuernavaca, State of Morelos, 22 August, 1897, *Pringle 6660* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); "torrent qui descende de Monte San Miguel, vers Lama de la Huerta," alt. 2200 m., vicinity of Morelia, State Michoacán, 10 November, 1910, *Bro. G. Arsène 3653* (U. S. Nat. Herb.).

The species is variable in habit, ranging to almost terrestrial, from the appearance of herbarium material. The species *I. Montezumae* was based on material collected by Pringle in the states of Mexico and Morelos. The distinctive difference in the herbarium specimens lies in the presence of tiny basal scales in some of this material. Since there is variability in this feature in other forms, as *I. Nuttallii* A. Br., probably in accordance with the amount of moisture present, and since the plants growing in shallow water fail to show such persistent leaf-bases, the character is considered ecological. The species is accordingly reduced.

Pringle's No. 13261 is unusual in showing megaspores as large as 660 μ in diameter, but otherwise agrees with the type. These were collected from the soil, but spores from the sporangia were as large as 520 μ, outside the range shown by any other material available.

38. I. melanopoda Gay & Dur. Bull. Soc. Bot. Fr. **11**: 102. 1864; Engelm. Bot. Gaz. 3: 1. 1878; Baker, Jour. Bot. 18: 105. 1880, and Fern Allies, 128. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 372. *pl. 14. fig. 1–3.* 1883; A. A. Eaton in Gray, Manual, ed. 7, 61. 1908.

I. melanopoda var. *pallida* Engelm. Trans. St. Louis Acad. Sci. 4: 387. 1882.

Calamaria melanopoda Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed; leaves 15–60, 15–40 cm. long, slender, erect, firm, bright green, usually black and shining at base, with usually pale membranaceous border, little (2–3 cm.) extended above sporangium level; stomata present; peripheral strands 4 or 6 cardinal, plus as many as 14 accessory groups; ligule subulate triangular; sporangia oblong, 0.5–3 cm. long, marked by numerous brown spots; velum variable, from very narrow to covering 1/2 of sporangium; megaspores 280–440 μ in diameter, marked with low tubercles, frequently confluent into short low wrinkles; microspores frequently ashy-gray, 20–30 μ long, fine spinulose.

Distribution: Illinois, Missouri, Iowa, Oklahoma, and Texas.

Specimens examined:

Illinois: Ringwood, 1863, *Vasey* (Mo. Bot. Gard. Herb. and Gray Herb.); wet meadows, without date, *Hall* (Gray Herb.); shallow border of pond, near Wady Petra, Stark Co., 30 June, 1898, *Chase 86* (Mo. Bot. Gard. Herb.); drying bed of shallow pond near Wady Petra, 26 July, 1898, *Chase 136* (Mo. Bot. Gard. Herb.); Athens, Menard Co., *Hall* (Gray Herb.); Athens, 1861, *Hall* (Gray Herb.); Athens, September, 1861, *Hall* (U. S. Nat. Herb.); ponds, Athens, Menard Co., July, 1863, *Dement* (Mo. Bot. Gard. Herb.); from small pond, in water, 6 inches deep, Athens, Menard Co., 3 June, 1865, *Hall* (Mo. Bot. Gard. Herb.); pond dry for several days, Athens, 13 June, 1865, *Hall* (Gray Herb.); Athens, 27 June, 1865, *Hall* (Mo. Bot. Gard. Herb. and Gray Herb.); "wet prairies, shallow ponds, now dry, in spring under water," 19 June, 1865, Athens, *Hall* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Athens, 30 October, 1865, *Hall* (Mo. Bot. Gard. Herb.); Athens, second crop, in water, 3 November, 1865, *Hall* (Gray Herb.); Athens, 25 November, 1865, *Hall* (Mo. Bot. Gard. Herb.); "second crop," Athens, 18 November, 1865, *Hall* (Mo. Bot. Gard. Herb.); Athens, 1

June and October, 1866, *Hall* (Mo. Bot. Gard. Herb.); Fulton Co., 1874, *Wolf* (Gray Herb.); "cultures in Jardin botanique de Bordeaux" sent from Athens by *Hall,* 2 August, 1876, *ex Herb. Motelay* (Mo. Bot. Gard. Herb.); Athens, 23 June, 1878, *Hall* (Mo. Bot. Gard. Herb.); Athens, 8 July, 1878, *Hall* (Mo. Bot. Gard. Herb.); Bluffs Lake, St. Clair Co., June, 1881, *Eggert* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Univ. Minn. Herb.); Bluffs Lake, St. Clair Co., 15 June, 1882, *Eggert* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); Bluffs Lake, St. Clair Co., 22 June, 1882, *Eggert* (Mo. Bot. Gard. Herb.); "banks of a pond, East St. Louis," St. Clair Co., 9 August, 1882, *Eggert* (Mo. Bot. Gard. Herb.); "Illinois, August," *Mrs. J. M. Milligan* (U. S. Nat. Herb.).

Iowa: Clinton, 1863, *Vasey* (Mo. Bot. Gard. Herb. and Gray Herb.).

Missouri: wet prairies, Little Blue River near Courtney, Jackson Co., 6 July, 1893, *Bush* (Mo. Bot. Gard. Herb.); Jackson Co., wet dogwood flats, uncommon, 6 July, 1893, *Bush 441* (Gray Herb.); Little Blue, Jackson Co., 24 May, 1896, "uncommon," *Bush 746* (Mo. Bot. Gard. Herb.); along, and in, ditches near Little Blue, east of Independence, "very local and rare," 24 May, 1896, *Bush* (Mo. Bot. Gard. Herb.); uncommon on low prairie, Dodson, Jackson Co., 2 May, 1897, *Bush 267* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); common in swale, Dodson, 28 June, 1898, *Bush 35* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); common on limestone ledges, Eagle Rock, Barry Co., 3 June, 1897, *Bush 107* (Mo. Bot. Gard. Herb.); Lake City, Jackson Co., *Mackenzie* (Univ. Wyoming Herb.); right bank of St. Francois River, below mouth of Stout Creek, Madison Co., 25 May, 1918, *Greenman 3861* (Mo. Bot. Gard. Herb.); springy bank of St. Francois River, near entrance of Stout Creek, 25 May, 1918, *Pfeiffer 21* (Mo. Bot. Gard. Herb.).

Oklahoma: "overflowed places," Limestone Gap, early June, 1875, *Butler* (Mo. Bot. Gard. Herb.); low wet places in alkali flats, Limestone Gap, 26 May, 1877, *Butler* (Mo. Bot. Gard. Herb.); pools, Limestone Gap, 14 June, 1877, *Butler* (Mo. Bot. Gard. Herb.); "alluvial deep shade in the bed of a dried-up stream," Limestone Gap, 16 June, 1877, *Butler*

(Mo. Bot. Gard. Herb.); pools 1½ mi. north of Limestone Gap, 8 July, 1877, *Butler* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); pool by the railroad, Limestone Gap, 10 July, 1877, *Butler* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.).

Texas: wet pine-woods, Houston, 20 April, 1872, *Hall 859* (Mo. Bot. Gard. Herb., Gray Herb., and N. Y. Bot. Gard. Herb.); Houston, May, 1872, *Hall* (Gray Herb.); swampy grounds, Dallas, June, 1877, *Reverchon 1177* (U. S. Nat. Herb.); wet sands, Dallas, July, 1880, *Reverchon 1177* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); mud, bogs, Buzzards' Spring near Dallas, June, 1877, *Reverchon 795* (Gray Herb.); Buzzards' Spring, 1879, *Reverchon* (Mo. Bot. Gard. Herb.); dried pond, Sabine River Bottoms, near Mineola, Wood Co., 2 June, 1903, *Reverchon 3551* (Mo. Bot. Gard. Herb.); shallow ponds, Pine's Island, Angelina Co., 5 May, 1903, *Reverchon 3549* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); Harrisburg, 9 May, 1876, *Joor* (Mo. Bot. Gard. Herb.); rare in pond, Columbia, 17 October, 1900, *Bush 1531* (Mo. Bot. Gard. Herb.); Hockley, 1891, *Thurow 15* (U. S. Nat. Herb.).

Although the early material of *I. melanopoda* appeared quite uniform and therefore the species seemed distinctive, more recent collections tend to add divergent forms. Engelmann early described a variety *pallida,* which he based on "larger plants lacking the black leaf bases of the type, with broader velum and megaspores in the restricted range of 300–350 μ, instead of the 250–400 μ range given for the type." This was based on Texas collections which upon examination show a wide difference in spore sizes, running as high as 440 μ. These specimens do not exceed northern forms in leaf number nor in leaf length. Moreover, it frequently happens that pale-based individuals are found in any stand of *I. melanopoda,* even though there be a preponderance of dark-based forms. It seems proper, therefore, to consider *pallida* as a form rather than as a variety of *I. melanopoda,* occurring singly or in stands.

There is, moreover, intergrading between two species, in the case of *I. melanopoda* and *I. Butleri,* so that some intermediate forms are difficult to place accurately. As an illustration, the examples originally described as *I. Butleri* var. *immaculata* combine in remarkable fashion the fine leaf habit of *I. Butleri* with

the greater length of *melanopoda* and frequently the stronger bulb development of the latter. The range in spore size is intermediate, overlapping the larger of *I. melanopoda* and the smaller of *I. Butleri.*

Much of the material representing this form has been collected in early spring. It is a question whether the fineness of leaves is related to the early development, as the lack of pigment seems to be. Certain it is that some stations have yielded only material labeled *"Butleri immaculata"* in May, and only *"melanopoda"* in June and July. Whether *I. Butleri* as found in Oklahoma (Indian Territory) by Butler, owed its characteristic size and fineness to the alkali flats in which it developed, is another ecological point worth determining. The series from *I. melanopoda* developing in moisture through so-called *pallida,* in drier surroundings, to *I. Butleri,* conceivably might be related to the environment. Pending further evidence in regard to relation, material showing the characteristic habit of *I. Butleri* is placed with that species, though most of it occurring outside of Oklahoma shows the combination of characters which connect it quite definitely also with *I. melanopoda.*

39. I. Butleri Engelm. Bot. Gaz. 3: 1. 1878; Baker, Jour. Bot. 18: 105. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 360. 1883; Engelm. Trans. St. Louis Acad. Sci. 4: 388. 1882; A. A. Eaton in Gray, Manual, ed. 7, 61. 1908.

I. Butleri var. *immaculata* Engelm. Trans. St. Louis Acad. Sci. 4: 388. 1882.

Calamaria Butleri Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed; leaves 8–30, 8–15 cm. long, more slender and rigid than *I. melanopoda,* tapering to apex; stomata numerous; peripheral strands usually 4, sometimes more in number; ligule elongated, cordate at base; sporangium oblong, 6–7 mm. long, marked with brown lines; velum very narrow; megaspores variable, commonly 480–650 μ in diameter, sometimes only 360 μ, marked with numerous tubercles, usually distinct, occasionally confluent; microspores 27–37 μ long, papillose.

Distribution: Tennessee, Missouri, Arkansas, Kansas, and Oklahoma.

Specimens examined:

Tennessee: Cedar Glades, Lavergne, May, *Gattinger* (N. Y. Bot.

Gard. Herb.); springy places in cedar barrens, near Lavergne, Rutherford Co., 7 and 17 May, 1880, *Gattinger 3812* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and U. S. Nat. Herb.); cedar barrens at Lavergne, 17 May, 1880, *Gattinger* (Gray Herb.); springy places in limestone flats near Nashville, April, 1886, *Gattinger* (Gray Herb.).

Missouri: common on limestone ledges, Eagle Rock, 3 June, 1897, *Bush 107* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Univ. Minn. Herb.); common in barrens, Eagle Rock, 22 May, 1898, *Bush 231* (Gray Herb. and N. Y. Bot. Gard. Herb.); common in barrens, Forsyth, 10 June, 1899, *Bush 68* (Mo. Bot. Gard. Herb., Gray Herb., U. S. Nat. Herb., and N. Y. Bot. Gard. Herb.); rocky barrens, Noel, 11 May, 1915, *Bush 7547* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.); wet barrens, Swan, 19 May, 1905, *Bush 2917* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); wet barrens, Swan, 17 May, 1907, *Bush 4511* (Mo. Bot. Gard. Herb., Gray Herb., and N. Y. Bot. Gard. Herb.); rocky hillsides, Jefferson Co., 26 May, 1891, *Eggert* (Mo. Bot. Gard. Herb., Gray Herb., U. S. Nat. Herb., and Univ. Minn. Herb.); rocky hillside, De Soto, Jefferson Co., 29 May, 1891, *Eggert* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); rocky hillside, De Soto, Jefferson Co., 11 and 25 May, 1896, *Eggert* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); De Soto, Jefferson Co., without date, *Eggert* (N. Y. Bot. Gard. Herb.); thin black soil on seeping ledges, limestone barrens 4 mi. northwest of Carthage, Jasper Co., 21 April, 1922, *Palmer 20848* (Mo. Bot. Gard. Herb.); moist depressions in limestone barrens, near Webb City, Jasper Co., 29 May, 1922, *Palmer 21555* (Mo. Bot. Gard. Herb.).

Arkansas: common in barrens, 8 May, 1902, *Bush 1530* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and U. S. Nat. Herb.); wet barrens near Eureka Springs, 8 May, 1902, *Canby 136* (Gray Herb.).

Kansas: rocky soil, Cherokee Co., May, 1897, *Hitchcock 1068* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., Gray Herb., and N. Y. Bot. Gard. Herb.).

Oklahoma: common on alkali flats, Limestone Gap, Atoka Co., first week in June, 1875, *Butler* (Mo. Bot. Gard. Herb.); alkali flats near Limestone Gap, 26 and 28 May, 1877, *Butler*

(Mo. Bot. Gard. Herb.); flats near Limestone Gap, 13 and 16 June, 1877, *Butler* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Limestone Gap, 16 June, 1887, *Butler 24* (N. Y. Bot. Gard. Herb.).

Sect. 2. Echinatae

§ 2. Echinatae. Forms with 2-lobed corms; producing megaspores with distinct spines; microspores smooth or rough; peripheral strands lacking; never terrestrial.

Key to Species

A. Stomata absent.
  a. Velum narrow, covering less than ⅓ of sporangium ---------- *40. I. echinospora*
  b. Velum wide, covering ⅔–¾ of sporangium ---------- *40a. I. echinospora* var. *asiatica*

B. Stomata present.
  a. Megaspores with sharp spines.
    α. Smaller forms, leaves 3–6 cm. in length ---------- *41. I. Brochoni*
    β. Larger forms, leaves chiefly 8 cm. or more in length ---------- *42. I. Braunii*
  b. Megaspores with blunt spines.
    α. Leaves few, 7–15, slender ---------- *42a. I. Braunii* var. *maritima*
    β. Leaves more numerous, 20–40, stout ---------- *43. I. truncata*

40. I. echinospora Dur. Bull. Soc. Bot. Fr. 8: 164. 1861; A. Br. Verh. Bot. Ver. Brandenb. 4: 297. 1862; Babington, Jour. Bot. 1: 1–5. 1863; Milde, Fil. Eur. 279. 1867; Baker, Jour. Bot. 18: 67. 1880, and Fern Allies, 125. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 334. *pl. 9.* 1883; Engelm. Trans. St. Louis Acad. Sci. 4: 379. 1882.

Calamaria echinospora Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed; leaves 10–40, 5–12 cm. long, pale green, stout at base, tapering to apex, spreading, recurved, with rather wide membranaceous margins at base; stomata none; peripheral strands none; ligule deltoid, rather wide at base; sporangia globose or oval, 3–7 mm. long, with very narrow velum; megaspores white, 440–540 μ in diameter, densely echinate with fine truncate spines, sometimes toothed; commissural ridges irregular in outline; microspores 23–35 μ in length, rarely 40 μ, sometimes marked with slight reticulations.

Distribution: British Isles, northern and central Europe.

Specimens examined:

British Isles: Wales, "In Cambriae lacu Llyn Padark," with *I. lacustris*, 30 September, 1862, *Gay* (Gray Herb.).

Belgium: Genck-Limbourg, 31 July, 1865, *ex herb. Thielens* (N. Y. Bot. Gard. Herb.); "Belgium," *Le Roy* (N. Y. Bot. Gard. Herb.); Etang à Genck, prov. Limbourg, August, 1862, *Van den Born* (Mo. Bot. Gard. Herb.).

France: Lac de Guery, Puy-de-Dome, 24 August, 1861, *Durieu* (Mo. Bot. Gard. Herb.), TYPE; Lac de Guery, Puy-de-Dome, 21 September, 1881, *Heribaud* (N. Y. Bot. Gard. Herb.); Lac de Guery, August, 1890, *Hy* (Mo. Bot. Gard. Herb.); Lac St. Andéol, Mt. Aubrac, 23 August, 1861, *Gay* (Mo. Bot. Gard. Herb. and Gray Herb.); in Longemer, near Colmar, Vosges, 26 July, 1865, *Schlickum* (N. Y. Bot. Gard. Herb.); Gerardmer (Vosges), August, 1867, *Martin* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Lac de Longemer, Vosges, September, 1874, *Stahl* (Mo. Bot. Gard. Herb.); Lac de Guery, August, 1890, *Cosson* (Gray Herb.).

Italy: Lago d'Orta near Busca, Prov. of Novara, 15 September, 1896, *Chiovenda* (Mo. Bot. Gard. Herb.); Lago d'Orta, August, 1856, *Franzoni* (Mo. Bot. Gard. Herb.); borders of "lacus Cusii" (lago d'Orta—Ital. bor.), 1857, *Cesati* (Mo. Bot. Gard. Herb.).

Norway and Sweden: in lakes of Norway, *Blytt 1951* (Mo. Bot. Gard. Herb.); Krigsbergs, Ivarinsbruk, 17 August, 1866, *Duscu* (U. S. Nat. Herb.); Nerêc Gotlunda, 1864, *Blomberg* (N. Y. Bot. Gard. Herb.); Nyland, Strömfors, 20 July, 1875, *Arrhenius* (N. Y. Bot. Gard. Herb.); near Stockholm, *Anderssen* (Mo. Bot. Gard. Herb.); Vg. Fröjered, August, 1880, *Junger* (N. Y. Bot. Gard. Herb.).

Germany: Feldsee, August, 1846, *Braun* (Mo. Bot. Gard. Herb.); Titisee, Schwarzwald, August, 1864, *Reess* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); Titisee near Freiburg, August, 1864, *Solms & Reess* (Mo. Bot. Gard. Herb.); Titisee, October, 1863, *de Bary* (Mo. Bot. Gard. Herb.); Feldsee, Schwarzwald, September, 1861, *Thiry* (Mo. Bot. Gard. Herb. and Gray Herb.); Feldsee in Schwarzwald, 1861, *ex. Mus. bot. Berol.* (U. S. Nat. Herb., 594573); Titisee, August, 1864, *Thiry* (Gray Herb.); Schluchsee (royal forest of Baden), 1864, *Braun* (Gray Herb.); Feldsee, 1884, *Christ* (N. Y. Bot. Gard. Herb.); in Feldsee, Schwarzwald, 4

August, 1881, *Study* (N. Y. Bot. Gard. Herb.); sandy shores at upper end of the Schluchsee, October, 1861, *Schildknecht & Thiry 799* (N. Y. Bot. Gard. Herb.); Titisee, September, 1868, *Zickendrath* (N. Y. Bot. Gard. Herb.).

Russia: in Livonia, distr. Riga, "in lacu Bule-See", 10 September, 1901, *Kupffer 14912* (U. S. Nat. Herb.).

40a. Var. **asiatica** Makino, Tokyo Bot. Mag. 18: 129. 1904.

Differs from the type in having a broad velum, covering 2/3 to 3/4 of the sporangium, in bearing coarser spinules on the megaspores, and in the smoothness of the microspores. The author suggests that it is lacking in stomata by saying that it differs from *I. Braunii* which has stomata and a spotted sporangium.

Distribution: rare. Lake Nojiri, Prov. Shinano.

Description from Makino.

41. I. Brochoni Motel. & Vendr. Actes Soc. Linn. Bord. 45: 45. *pl. 2.* 1893.

Corm 2-lobed; leaves 8–16, rarely more, 3–6 cm. long, fine, tapering, rosy below, green above, with short, wide membranaceous margin at base; stomata present but not common; peripheral strands none; ligule very short and broad; sporangium globose, 2½–4 mm. long, partially (1/4–1/3) covered by velum; megaspores white, 450–525 μ in diameter, much flattened in outline, marked with very echinate, sharply toothed prominences; microspores 33–53 μ in length, often nearly as wide.

Distribution: France.

Specimens examined:

France: Lac de Naguilles (1854 m. alt.), Ariege, *Motelay* (Mo. Bot. Gard. Herb.), TYPE; Lac de Naguilles, August, 1891, *Hy* (Mo. Bot. Gard. Herb.).

42. I. Braunii Dur. Bull. Soc. Bot. Fr. 11: 101. 1864.

I. echinospora var. *Braunii* Engelm. in Gray, Manual, ed. 5, 676. 1867.

I. echinospora var. *Boottii* Engelm. in Gray, Manual, ed. 5, 676. 1867.

I. echinospora var. *muricata* Engelm. in Gray, Manual, ed. 5, 676. 1867.

I. echinospora Braunii f. *Boottii* Clute, Fern Allies, 221, 258. 1905.

I. echinospora Brittoni Cockerell, Muhlenbergia 3: 9. 1907.

I. muricata Dur. Bull. Soc. Bot. Fr. 11: 101. 1864.

I. ambigua A. Br. in Engelm. Trans. St. Louis Acad. Sci. 4: 380. 1882.

Corm 2-lobed; leaves usually 10–35, in robust forms 27–55, 8–25 cm. long, or rarely longer, straight or recurved, firm, tapering to apex, with rather wide base with membranaceous borders; stomata present, usually few; peripheral strands none; ligule deltoid; sporangia oblong, spotted, 4–7 mm. long, with velum ½ to completely covering it (western forms of U. S. have narrow velum); megaspores white, 420–580 μ in diameter, marked with numerous spines ranging from single slender spines to those toothed or even confluent in short ridges; microspores fawn-colored, 23–33 μ long, smooth to slightly roughened on surface.

Distribution: North America.

Specimens examined:

Greenland: 60°–60° 43′ N. lat., Southern Greenland ("Tessermint"), probably about 1825, *Jens Vahl* (Mo. Bot. Gard. Herb.); Kingua Neriak, 61° 35′, July, 1889, *Hartz* (Gray Herb.).

Newfoundland: immersed, sandy soil, Channel, 27 July–1 August, 1901, *Howe & Lang 954* (Gray Herb. and N. Y. Bot. Gard. Herb.); small ponds among Siberian Hills back of Birchy Cove (Curling), region of Humber Arm, Bay of Islands, 11 August, 1910, *Fernald & Wiegand 2402* (Gray Herb.); barrens at base of the serpentine table-lands, Bonne Bay, 27 August, 1910, *Fernald & Wiegand 2405* (Gray Herb.); gravelly brook in bog, Bishop Falls, 29 July, 1911, *Fernald & Wiegand 4411* (Gray Herb.); shallow pools in bog, Bishop Falls, Valley of Exploits River, 29 July, 1911, *Fernald & Wiegand 4406* (Mo. Bot. Gard. Herb. and Gray Herb.); shallow pools in the tundra near Quarry (Laurentian Area at head of Exploits River System), 23 August, 1911, *Fernald & Wiegand 4401* (Gray Herb.); deep water near center of middle Birchy Pond (eastern drainage area of Humber River System), *Fernald & Wiegand 2400* (Gray Herb.); wet

sandy shore of Rushy Pond (Valley of Exploits River), 11 August, 1911, *Fernald & Wiegand 4410* (Gray Herb.); muddy pool, Killigrew's (shores of Conception Bay, Avalon Peninsula), 3 August, 1911, *Fernald & Wiegand 4405* (Gray Herb.); diorite tableland, alt. about 550 m., n. region of the Blomidon ("Blow-Me-Down") Mts., 22 August, 1910, *Fernald & Wiegand 2401* (Gray Herb.); Eastern Avalon Peninsula, bog pond on hill south of St. Johns, 2 August, 1911, *Fernald & Wiegand 4407* (Gray Herb. and U. S. Nat. Herb.); Kitty's Brook, eastern waters of the Humber River System, 25 August, 1911, *Fernald & Wiegand 4403* (Gray Herb.); shallow pools on serpentine tableland, alt. about 550 m., northeast region of the Blomidon Mts., w. Newfoundland, 21 August, 1910, *Fernald & Wiegand 2403* (Gray Herb.).

Quebec: Grand Valley, Gaspé, 3 August, 1882, *John Macoun 14220* (Gray Herb.); Madeline River, Gaspé, 5 August, 1882, *John Macoun 14226* (Gray Herb.); lake near Point Fame, Gaspé, 5 August, 1882, *John Macoun 14224* (Gray Herb.); Beau Lac, 14 August, 1902, *Eggleston 3026* (Gray Herb., N. Y. Bot. Gard. Herb., and Dudley Herb.); alpine lakes, 900–1000 m., Table-top Mt., Gaspé, 4 August, 1906, *Fernald & Collins 311* (Mo. Bot. Gard. Herb.); Lac Fortin, Table-top Mt., Gaspé, 10 August, 1906, *Fernald & Collins 320* (Gray Herb.); in muck over granite, Lac 33, Table-top Mt., Gaspé, 4 August, 1906, *Fernald & Collins 316* (Gray Herb.); Lac des Americains, 675 m., western-base Table-top Mt., Gaspé, 1 and 2 August, 1906, *Fernald & Collins 154* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., U. S. Nat. Herb., Gray Herb., and Univ. Minn. Herb.); Granite Block Pond, alt. 900–1000 m., Table-top Mt., 7 August, 1906, *Fernald & Collins 318* (Mo. Bot. Gard. Herb. and Gray Herb.); Sargent's Bay, Lake Memphremagog, 3 August, 1903, *Churchill* (Mo. Bot. Gard. Herb.); Mt. Elephantis Landing, Lake Memphremagog, 14 August, 1903, *Churchill* (Mo. Bot. Gard. Herb. and Gray Herb.); pool (tidal?) at mouth of river, Romaine, Lagorgendière, Saguenay, 8 July, 1915, *St. John 90061* (Gray Herb.); growing at least 5 ft. below surface of water, Lake Pratt, near Rivière du Loup, July, 1913, *Bro. Victorin 61* (Gray Herb.); sub-

merged, Lake MacGregor, 3 August, 1917, *Bro. Rolland 6284* (N. Y. Bot. Gard. Herb.); Kirck's Ferry, 16 August, 1916, *Bro. Rolland 65* (Mo. Bot. Gard. Herb.); Richelieu River, Isle Allo-None, 13 August, 1918, *Bro. Victorin* (N. Y. Bot. Gard. Herb.); Lake Pratt Co., Temiscouata, August, 1914, *Bro. Victorin 694* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Gray Herb.); in 1 ft. water in sandy-bottomed pond, Petit Rivière Coxipi, Brouage, Saguenay Co., 23 July, 1915, *St. John 90059* (Gray Herb.); shallow pool in tundra, Anse Portage, Archipel de St. Augustin, Saguenay Co., 5 August, 1915, *St. John 90060* (Gray Herb.); 1 ft. of water, hillside pond, Baie des Moutons, Boishébert, Saguenay Co., 15 August, 1915, *St. John 90058* (Gray Herb.).

New Brunswick: Lily Lake, St. Johns, 8 August, 1873, *Boott* (Gray Herb.); St. George, Charlotte Co., 17 August, 1883, *Vroom* (Gray Herb.); muddy pool on shores of St. John River, Connors, Madawaska, 13 July, 1903, *Pease 2249* (Gray Herb.).

Nova Scotia: Shelburn, August, 1873, *James* (Mo. Bot. Gard. Herb.); South Ingonish, 8 August, 1898, *Macoun* (Mo. Bot. Gard. Herb.); Boylston, August, 1890, *Hamilton 81051* in part (Gray Herb.); N. E. Margaree, Cape Breton Isl., 11 August, 1906, *Robinson 335* (N. Y. Bot. Gard. Herb.); (probably) margin of Taylor's Lake, Sunny Brae, Pictou Co., 30 July, 1913, *St. John 1370* (Gray Herb.); muddy lagoon, Charcoal, Valley of the East River, Pictou Co., 2 August, 1913, *St. John 1371* (Gray Herb.); muddy and rocky bottom of a quiet brook, New Tusket, 9 August, 1921, *Fernald & Long 23113* (Mo. Bot. Gard. Herb.).

Maine:

Aroostook Co.: sandy bottom of Beau Lac, 14 August, 1902, *Fernald* (Mo. Bot. Gard. Herb.); Beau Lac, 14 August, 1902, *Eggleston 3026* (U. S. Nat. Herb.); ledgy margin of river, St. Francis, 19 August, 1893, *Fernald 220* (Mo. Bot. Gard. Herb., Gray Herb., N. Y. Bot. Gard. Herb., U. S. Nat. Herb., and Univ. Minn. Herb.); sandy bed of Pettiquaggimas (Glazier) Lake, 8 August, 1893, *Fernald 218* (Mo. Bot. Gard. Herb.); gravelly margin of River St. Francis, 21 August, 1893, *Fernald 219* (Mo. Bot. Gard. Herb., Gray Herb., U. S. Nat. Herb., and Univ. Minn. Herb.); logan by

the river, Fort Kent, 11 August, 1901, *Fernald* (Gray Herb.); logan in St. Johns River, Fort Kent, 11 August, 1901, *Williams 1* (Gray Herb.); bed of Dyer Brook, Island Falls, 28 August, 1897, *Fernald* (Gray Herb.); rapids of St. Croix Stream, Masarde's, 8 September, 1897, *Fernald* (Gray Herb.); river margin, Madawaska, 28 July, 1893, *Fernald* (Gray Herb.).

Penobscot Co.: Pushaw Pond, August, 1899, *F. L. Harvey 2* (Mo. Bot. Gard. Herb.); ledgy margin of Stillwater River, Orono, 4 September, 1893, *Fernald y & g* (Gray Herb. and N. Y. Bot. Gard. Herb.); Chemo Stream, Bradley, 10 August, 1898, *F. L. Harvey* (Mo. Bot. Gard. Herb.); submerged, growing in rock crevices, Chemo Stream, Bradley, 15 July, 1898, *F. L. Harvey* (N. Y. Bot. Gard. Herb.); Chemo Pond, August, 1897, *Merrill* (U. S. Nat. Herb.); same, September, 1897 (Gray Herb.); Chemo Stream, Bradley, September, 1897, *Merrill 10* (N. Y. Bot. Gard. Herb.); tidal mud flats at mouth of Souadabscook Stream, Hampden, 11 September, 1916, *Fernald & Long 12341* (Gray Herb. and Mo. Bot. Gard. Herb.); river margin, Mattawamkeag, 14 September, 1898, *Fernald 2819* (Gray Herb.); muddy river margin, Orono, 1 September, 1893, *Fernald x* (Gray Herb.); tidal mud flats at the mouth of Reed Brook, Hampden, 8 September, 1916, *Fernald & Long 12340* (Gray Herb. and Mo. Bot. Gard. Herb.); mud in crevices of slate, immersed at margin of Mud Pond, Oldtown, 29 August, 1908, *Fernald* (Gray Herb.).

Washington Co.: margin of Lambert Lake, 1 September, 1908, *Plantae Exsiccatae Grayanae, Fernald* (Mo. Bot. Gard. Herb.); granitic gravel and silt at margin of Lambert Lake, 1 September, 1908, *Fernald 105* (Gray Herb. and Dudley Herb.); sandy margin of Pennamaquan River, Pembroke, 18 August, 1909, *Fernald 1215* (Gray Herb.); muddy bed of brook, Cutter, 29 August, 1902, *Fernald* (Gray Herb.).

Hancock Co.: Mt. Desert Isl., Long Pond meadows, Jordan's Stream, 26 August, 1891, *Rand* (N. Y. Bot. Gard. Herb.); bog hole, Long Pond Meadows, 20 September, 1898, *Rand* (Gray Herb.); "Mt. Desert Isl.," *Rand* (Mo. Bot. Gard. Herb.); in clay mud, beach, southeast end of Great Pond, 19 September, 1898, *Rand* (Gray Herb.); stream, meadow

north of Long Pond, Seal Harbor, 21 August, 1889, *Rand* (Gray Herb.); brook, Long Pond Meadows, Seal Harbor, 21 August, 1889, *Redfield 2530* (Mo. Bot. Gard. Herb. and Gray Herb.); muddy pond, Long Pond meadows, 9 September, 1899, *Rand* (Gray Herb.).

Piscataquis Co.: Milo, 2 September, 1897, *Fernald* (Mo. Bot. Gard. Herb. and Gray Herb.); Mt. Katahdin, September, 1898, *Merrill 1408* (U. S. Nat. Herb.); mostly submerged, Three Ponds, Mt. Katahdin, alt. 1500–1800 ft., September, 1898, *Merrill* (N. Y. Bot. Gard. Herb.); Mt. Katahdin, 15–30 August, 1902, *Cowles & Harvey 2* (Mo. Bot. Gard. Herb.); muddy river bottom, Dover, 27 August, 1894, *Fernald* (Gray Herb.); gravelly margin of river, Dover, 3 September, 1894, *Fernald* (Gray Herb.); submerged margin of Pleasant River, Brownville, 3 August, 1904, *Parlin 1753* (Gray Herb.).

Somerset Co.: Lake George, Skowhegan, 30 June and 2 July, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Dead River, 15 August, 1896, *Eaton* (Mo. Bot. Gard. Herb.); quiet pool in river, Dead River, 15 August, 1896, *Fernald* (Gray Herb.).

Waldo Co.: deadwaters of the stream, Frankfort, 21 July, 1916, *Fernald & Long 12338* (Gray Herb. and Mo. Bot. Gard. Herb.).

Knox Co.: Chickawaukie Pond, Rockland, *Fernald 1214* (Gray Herb.).

Lincoln Co.: muddy shore, Pemaquid River, in about 6 in. water, Bremen, 27 August, 1899, *Chamberlain* (Gray Herb.).

Kennebec Co.: cold spring-pool in margin of brook, Sydney, 18 August, 1916, *Fernald & Long 12339* (Gray Herb.); river margin, in mud, Waterville, 2 September, 1898, *Fernald 2824* (Gray Herb.); Cobbossee Contee Lake, Winthrop, August, 1898, *Battey* (Gray Herb.); Winthrop, 28 August, 1898, *Battey* (Gray Herb.).

Sagadahoc Co.: tidal mud flats of the river, Bowdoinham, 14–19 September, 1916, *Fernald & Long 12342* (Gray Herb. and Mo. Bot. Gard. Herb.); border of salt marsh, Back River Creek, Woolwich, 15 September, 1916, *Fernald & Long 12343* (Gray Herb.).

Franklin Co.: Bay Pond north of Bullhorse Pond, south end Great Pond, Industry, 14 August, 1894, *Fernald* (Mo. Bot. Gard. Herb. and Gray Herb.); cold spring entering North-

west Pond, n. Franklin Co., 14 July, 1895, *Coville 84* (U. S. Nat. Herb. and N. Y. Bot. Gard. Herb.); Wilson Stream, East Wilton, 11 August, 1894, *Fernald* (Gray Herb.).

Androscoggin Co.: river at Mechanics Falls, 28 August, 1897, *Allen* (Mo. Bot. Gard. Herb. and Gray Herb.); Lake Auburn, Auburn, 15 September, 1904, *Winslow* (Mo. Bot. Gard. Herb.); South Poland, 1893 and 1895, *Furbish* (Gray Herb.); Livermore Falls, *Furbish* (Gray Herb.).

Cumberland Co.: muddy bank, Androscoggin River, Brunswick, 1 August, 1894, *Davis* (U. S. Nat. Herb.); sandy bottom of Sand Pond, Baldwin, 30 August, 1916, *Fernald, Long & Norton 12337* (Gray Herb. and Mo. Bot. Gard. Herb.).

Oxford Co.: shallow water of brook, Buckfield, 8 August, 1894, *Allen* (Gray Herb.).

York Co.: in Newichawammick River, N. Berwick, 25 September, 1897, *Parlin & Fernald 922* (Gray Herb.); rocky bed of Great Works River, No. Berwick, 25 September, 1897, *Fernald* (in part) (Gray Herb.).

New Hampshire: wiers on Lake Winnipiseogee, 19 September, 1856, *Engelmann* (Mo. Bot. Gard. Herb. and Gray Herb.), TYPE; at mouth of "Sucker Brook" and in Lake Sunapee, 17 July, 1903, *Waters* (Mo. Bot. Gard. Herb.); Newmarket, 19 August, 1899, *Eaton* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); Country Pond, Newton, 18 August, 1896, *Eaton 441* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Alton Bay, 1894, *Eaton* (Mo. Bot. Gard. Herb.); Noyes Pond, Seabrook, 13 August, 1899, *Eaton ser. 2, 187* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); pond on Lamprey River, Epping, August, 1896, *Eaton* (Mo. Bot. Gard. Herb.); wiers on Lake Winnipiseogee, 23 September, 1863, *Mann* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Gray Herb.); Lake Winnipiseogee, 28 September, 1866, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Echo Lake, Franconia, 12 September, 1862, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Echo Lake, Franconia, 31 July, 1863, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Eagle Lake, Mt. Lafayette, alt. 4200 ft., 26 September, 1891, *E. & C. E. Faxon* (Gray Herb.); country pond, East Kingston, August, 1895, *Eaton* (Mo. Bot. Gard. Herb.); late form, out of water, East Kingston, 18 September, 1895, *Dodge*

(Gray Herb.); borders of pond, East Kingston, 6 October, 1895, *Eaton 699* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); "Dismal Pool" near mouth of Saco River, White Mt., 26 August, 1882, *E. & C. E. Faxon 10* (Mo. Bot. Gard. Herb. and Gray Herb.); Saco Lake, Crawfords, 17 July, 1893, *E. & C. E. Faxon 4* (Gray Herb.); Ammonoosuc Lake, Crawfords, 17 July, 1893, *E. & C. E. Faxon 3* (Gray Herb. and N. Y. Bot. Gard. Herb.); submerged flats at Kingston, August, 1896, *Eaton* (Mo. Bot. Gard. Herb.); early form growing submersed, East Flats, East Kingston, 28 July, 1896, *Dodge* (Gray Herb.); Flats, East Kingston, 28 July, 1896, *Eaton* (Mo. Bot. Gard. Herb.); Epping, *Eaton 431* (Mo. Bot. Gard. Herb.); Epping, 12 August, 1896, *Eaton 425a* (Mo. Bot. Gard. Herb.); West Epping, *Eaton 482b* (Mo. Bot. Gard. Herb.); Pautuckaway Pond, Nottingham, 29 July, 1896, *Eaton 483a* (Mo. Bot. Gard. Herb.); East Kingston, 28 July, 1896, *Eaton 364* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); sandy bottoms of ponds, East Kingston, August, 1895, *Eaton* (N. Y. Bot. Gard. Herb.); East Kingston, 6 July, 1896, *Eaton 239* (Mo. Bot. Gard. Herb.); Trickling Falls, East Kingston, 29 July, 1896, *Eaton* (Mo. Bot. Gard. Herb.); Rod Miller's, Seabrook, *Eaton* (Mo. Bot. Gard. Herb.); Conway Lake, 25 August, 1904, *Davenport* (Mo. Bot. Gard. Herb.); Lake Winnipisaukee, 10 September, 1910, *Sargent 27* (Gray Herb.); Gustin Pond, Marlow, 29 July, 1899, *Fernald 186* (in part) (Gray Herb.); clayey sand, shores of Thorndike Pond, 29 September, 1897, *Rand & Robinson 927* (Gray Herb.); Seabrook, September, 1895, *Eaton* (U. S. Nat. Herb. and Univ. Minn. Herb.); Gilmanton, 4 September, 1911, *Lunt 60* (Gray Herb.); shingly margin of Fish Pond, Columbia, Coos Co., 22 August, 1912, *Pease 13790* (Gray Herb.); sphagnous bogs, by small ponds near timber line, western slope of Mt. Lafayette, Franconia, 17–18 July, 1915, *Fernald & Smiley 11496* (Gray Herb.); Loutenstein, Asquam Lake, 13 August, 1914, *Gundersen* (Gray Herb.).

Vermont: Lake Dunmore, 1859, *Chapman* (Mo. Bot. Gard. Herb.); in small pond near summit of Mt. Mansfield, August, 1863, *Mann* (Gray Herb.); Lake of the Clouds, Mt. Mansfield, 10 August, 1876, *Pringle* (Mo. Bot. Gard.

Herb.); pond on Sterling Mt., 20 August, 1877, *C. E. Faxon 1* (Mo. Bot. Gard. Herb.); Notch Pond, Ferdinand, Essex Co., *Eggleston 1785* (Mo. Bot. Gard. Herb., Gray Herb., and N. Y. Bot. Gard. Herb.); Pike Pond, Stratton, August 6–10, 1900, *Eggleston 2201* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.); shallow water, Peacham, 14 August, 1884, *Blanchard* (N. Y. Bot. Gard. Herb. and Dudley Herb.); Foster's Pond, Peacham, September, 1881, *Blanchard* (Mo. Bot. Gard. Herb.); Stratton Plateau, Stratton, 6–10 August, 1900, *Eggleston 2201* (Dudley Herb.); Lake of the Clouds, Mt. Mansfield, 14 August, 1901, *Eggleston 2472* (U. S. Nat. Herb., Gray Herb., Mo. Bot. Gard. Herb. and Dudley Herb.); shallow muddy shores, Lake of the Clouds, Mt. Mansfield, 31 July, 1893, *Eggleston 699* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); Lake of the Clouds, Mt. Mansfield, 8 August, 1877, *Faxon 2* (Mo. Bot. Gard. Herb.); same place and date, without number, *Faxon* (Gray Herb.); small pond, Lake of the Clouds, Mt. Mansfield, August, 1863, *Mann* (Mo. Bot. Gard. Herb. and Gray Herb.); Lake of the Clouds, 31 July, 1893, *Hinsdale & Eggleston* (Dudley Herb. and U. S. Nat. Herb.); Larger Lake of the Clouds, 15 July and 31 July, 1893, *Miller 1 & 2* (Gray Herb.); Pleiad Lake, alt. 2500 ft., Hancock, 13 September, 1896, *Brainerd* (Gray Herb.); Chittenden, 18 August, 1895, *Eggleston* (Univ. Minn. Herb.); Joe's Pond, W. Danville, 5 July, 1894, *Burbank, Grout & Eggleston* (U. S. Nat. Herb. and N. Y. Bot. Gard. Herb.); muddy shores of Pike's Mill Pond, Stratton, 10 August, 1894, *Grout* (N. Y. Bot. Gard. Herb.); Lake Champlain, north end of Isle La Motte, 2 September, 1879, *Pringle* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and U. S. Nat. Herb.); North Pond, Stratton, 30 July, 1894, *Grout* (N. Y. Bot. Gard. Herb.); Lake Champlain, n. end of Isle La Motte, 19 July, 1878, *Pringle* (Mo. Bot. Gard. Herb.); muddy banks, Lower Haystack Pond, Wilmington, Windham Co., 6 October, 1912, *St. John 630* (Gray Herb.); Kelsey's Beach, in water 1–2 ft. deep, Lake Dunmore, Salisbury, 23 August, 1908, *Dutton 397* (Gray Herb.); Stony Pond, region of Pine Hill, Rutland, 25 July, 1909, *Dutton 198* (Gray Herb.); region Battell's Pond, alt. about 2500 ft., Hancock, 22 August, 1909, *Dutton 260* (Gray

Herb.); Connecticut River, Norwich, September, 1876, *Jesup* (N. Y. Bot. Gard. Herb.).

Massachusetts:

Essex Co.: Attitash, 27 June, 1896, *Eaton 197* (Mo. Bot. Gard. Herb.); muddy banks of Merrimac River, Newburyport, 1895, *Eaton* (Dudley Herb.); Attitash, 31 July, 1896, *Eaton 880* (Mo. Bot. Gard. Herb.); Kimballs Pond, Amesbury, 15 August, 1899, *Eaton 192* (Mo. Bot. Gard. Herb.); Kimballs Pond, Amesbury, 13 August, 1899, *Eaton* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); Kimballs Pond, Amesbury, 13 August, 1896, *Eaton* (Mo. Bot. Gard. Herb.); Tuxbury's Pond, Amesbury, 19 September, 1897, *Eaton 919* (Mo. Bot. Gard. Herb.); Marshall's Pond, Amesbury, 13 August, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Crane Pond, Bagfield, 6 July, 1893, *Lunt* (Gray Herb.); Bates Pond, Wenham, 29 July, 1896, *Eaton 377* (Mo. Bot. Gard. Herb.); Pleasant Pond, Wenham, *C. E. Faxon 6* (Mo. Bot. Gard. Herb.); Pleasant Pond, Wenham, without date or number, *C. E. Faxon* (Gray Herb.); Beaver Pond, Beverly, August, 1870, *Russell* (Mo. Bot. Gard. Herb.); bank of Merrimac, Newburyport, 12 September, 1895, *Eaton* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); bank of Merrimac, Newburyport, August, 1895, *Eaton* (N. Y. Bot. Gard. Herb.); Chattwick's Pond, W. Boxford, 1 September, 1882, *Robinson* (Mo. Bot. Gard. Herb.); banks of Merrimac R., Newburyport, 12 September, 1897, *Eaton* (Univ. Minn. Herb.); Manchester and vicinity, without date, *Chamberlain* (N. Y. Bot. Gard. Herb.); muddy pool, Amesbury, 13 August, 1899, *Eaton* (Univ. Minn. Herb.); Ipswich River, Ipswich, 29 July, 1874 and 1875, *Morong* (N. Y. Bot. Gard. Herb.); Ipswich River, Ipswich, July, 1875, *Morong* (U. S. Nat. Herb.); East Andover, 1903, *Holt* (Gray Herb.); Wenham, *Collins* (Gray Herb.); pond on Skug River, above Sawmill Road, 22 September, 1903, *Pease 2775* (Gray Herb.).

Middlesex Co.: Woburn, 16 November, 1862, *without collector's name* (Mo. Bot. Gard. Herb.); Woburn, 3 September, 1866, *Boott* (Gray Herb.); Small Round Pond, Woburn, 8 September, 1867, *Boott* (Mo. Bot. Gard. Herb.); Small Round Pond, Woburn, 23 September, 1867, *Boott* (Mo. Bot. Gard. Herb.); Small Round Pond, Woburn, 5 August, 1860, *Boott*

(Mo. Bot. Gard. Herb. and Gray Herb.); Small Round Pond, Woburn, 29 September, 1867, *Boott* (Mo. Bot. Gard. Herb.); Small Round Pond, Woburn, 11 August, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Small Round Pond, Woburn, 20 October, 1867, *Boott* (Mo. Bot. Gard. Herb.); Small Round Pond, Woburn, 9 June, 1867, *Boott* (Mo. Bot. Gard. Herb.); Small Round Pond, Woburn, 2 September, 1866, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Small Round Pond, Woburn, 18 September, 1866, *Boott* (Mo. Bot. Gard. Herb., Gray Herb., and N. Y. Bot. Gard. Herb.); Small Round Pond, Woburn, 14 July, 1867, *Boott* (Mo. Bot. Gard. Herb.); Small Round Pond, Woburn, 15 & 22 August, 1869, *Boott* (Gray Herb.); Mystic Pond, without date, *C. E. Faxon* (Gray Herb.); Mystic Pond, 6 August, 1865, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Mystic Pond, 30 July, 1865, *Boott* (Gray Herb.); Mystic Pond, 2 September, 1866, *Boott* (Mo. Bot. Gard. Herb.); Mystic Pond, 3 September, 1866, *Boott* (Gray Herb.); Mystic Pond, 14 June, 1867, *Boott* (Mo. Bot. Gard. Herb.); Mystic Pond, Medford, without date, *Boott* (Gray Herb.); pond in Woburn, without date, *Davenport* (Gray Herb.); Mystic Pond, 29 August, 1869, *Boott* (N. Y. Bot. Gard. Herb.); Sherman's Pond, Waltham, 31 August, 1869, *Boott* (N. Y. Bot. Gard Herb.); Spot Pond, Stoneham, 19 August, 1899, *Rich* (Gray Herb.); Spot Pond, Stoneham, without date, *Collins* (Gray Herb.); Skug River, North Reading, 14 September, 1903, *Pease 2670* (Gray Herb.); submerged in running water, Ashland, 17 July, 1879, *Morong* (N. Y. Bot. Gard. Herb.); Nutting Pond, Billerica, 11 August, 1869, *Boott* (N. Y. Bot. Gard. Herb.); sandy margin of Heard's Pond, Wayland, 10 September, 1909, *Fernald* (Gray Herb.); Mystic Pond, near Bacon's, 10 September, 1876, *Boott* (N. Y. Bot. Gard. Herb.); Mystic Pond at Grover, 29 August, 1869, *Boott* (N. Y. Bot. Gard. Herb.); Mystic Pond, 29 August, 1882, *Perkins* (Gray Herb.); Mystic Pond, 4 July, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Mystic Pond, 1 September, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); brook above gas works, Arlington, 1 September, 1867, *Boott* (Gray Herb.); Mystic Pond, mouth of Arlington Brook, 30 July, 1864, *Boott,* (Mo. Bot. Gard. Herb. and

N. Y. Bot. Gard. Herb.); Mystic Pond, mouth of Arlington Brook, 2 June, 1867, *Boott* (Mo. Bot. Gard. Herb.); along banks of Mystic Pond, 21 October, 1866, *Boott* (Mo. Bot. Gard. Herb.); Mystic Pond, 14 and 30 July, 1864, *Boott* (Gray Herb.); east side of Mystic Pond, 8 September, 1867. *Boott* (Mo. Bot. Gard. Herb.); west side of Mystic Pond, north of Brook, 12 July, 1868, *Boott* (Gray Herb.); south side of Spy Pond, Arlington, 5 and 9 September, 1867, *Boott* (Mo. Bot. Gard. Herb.); Spot Pond, 6 September, 1868, *Boott* (N. Y. Bot. Gard. Herb.); Spot Pond, Stoneham, 23 July, 1867, *Boott* (Mo. Bot. Gard. Herb.); Spot Pond, 18 November, 1866, *Boott* (U. S. Nat. Herb.); Horn Pond, Woburn, September, 1862, *Mann* (Gray Herb.); island in middle of Horn Pond, 11 July, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); northwest side Horn Pond, 16 September, 1869, *Boott* (N. Y. Bot. Gard. Herb.); Fresh Pond, 17 September, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Concord Brook, 20 August, 1866, *Boott* (Mo. Bot. Gard. Herb.); Round Pond, Woburn, 1 October, 1874, *Davenport* (N. Y. Bot. Gard. Herb.); Hammond's Pond, Brookline, without date, *C. E. Faxon* (Mo. Bot. Gard. Herb.); Round Pond, Woburn, without date, *C. E. Faxon* (Mo. Bot. Gard. Herb.); Hammond's Pond, 1878, *Farlow* (Mo. Bot. Gard. Herb.); Tofit Swamp Brook, Lexington, 17 July, 1867, *Boott* (Gray Herb. and N. Y. Bot. Gard. Herb.); brook in Tofit Swamp, Lexington, 9 September, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); South Natick, 14 July, 1879, *Morong* (Mo. Bot. Gard. Herb.); "entirely submerged in pool, South Natick", 13 August, 1883, *Morong* (N. Y. Bot. Gard. Herb.); ponds, West Cambridge, 1861, *Boott* (Mo. Bot. Gard. Herb.); Concord, in streams, September, 1863, *Mann* (Gray Herb.); Concord, 1 October, 1863, *Mann* (Mo. Bot. Gard. Herb.); Concord, without date, *Mann* (Gray Herb.); small pond in Winchester (formerly Woburn), August, 1876, *Morong 353* (U. S. Nat. Herb.); small pond in Winchester, 22 August, 1876, *Morong* (N. Y. Bot. Gard. Herb.); brooks, slow moving water, Melrose, 8 July, 1875, *Morong* (N. Y. Bot. Gard. Herb.); in running water, Melrose, September, 1876, *Morong* (U. S. Nat. Herb.); Sandbury River, Framingham, September,

1894, *Smith* (Mo. Bot. Gard. Herb.); from a canal in So. Natick, water about 1 ft. deep, 25 June, 1879, *Morong* (N. Y. Bot. Gard. Herb. and Mo. Bot. Gard. Herb.); entirely submerged, Charles R., So. Natick, 4 August, 1879, *Morong* (N. Y. Bot. Gard. Herb.).

Norfolk Co.: Neponset River, Readville, 28 July, 1870, *Boott* (N. Y. Bot. Gard. Herb.); Highland Lake, Norfolk, 1 August, 1909, *Ware 724* (Mo. Bot. Gard. Herb.); Hammond's Pond, Brookline, *C. E. & W. Faxon 8* (Gray Herb.); Lake Massapoag, 17 October, 1897, *Greenman 2314* (Mo. Bot. Gard. Herb.); Dedham, growing in shallow water, mud bottom, 24 July, 1902, *Forbes* (Gray Herb.); Lake Massapoag, 11 September, 1903, *Eaton* (Mo. Bot. Gard. Herb.); in Sutton's Brook, at its junction with Charles River, Needham, 12 July, 1885, *Fuller* (Gray Herb.).

Bristol Co.: Mulberry Brook, Easton, 16 August, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Flyaway Pond, No. Easton, 15 July, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Canoe River, 2 August, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Watson's Pond, Taunton, 12 July, 1903, *Eaton* (Mo. Bot. Gard. Herb.); few stations in stream, Swansea, 16 August, 1912, *Sanford 38* (Gray Herb.).

Worcester Co.: Massapoag Lake, 11 September, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Uxbridge, 30 August, 1864, *Robbins* (Mo. Bot. Gard. Herb. and Gray Herb.); "river," Uxbridge, 1 August, 1867, *Robbins* (N. Y. Bot. Gard. Herb.); pond, Grafton, 27 July, 1866, *Robbins* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); pond connected with Blackstone River, 30 August, 1864, *Robbins* (Mo. Bot. Gard. Herb.); Uxbridge, 1845, *Robbins* (Mo. Bot. Gard. Herb.); Uxbridge, without date, *ex. herb. Robbins* (N. Y. Bot. Gard. Herb.); millpond, depth of 2–3 ft., Uxbridge, 30 August, 1866, *Robbins* (Mo. Bot. Gard. Herb.); Cohasset Brook, Southbridge, alt. 640 ft., 12 August, 1899, *Harper* (N. Y. Bot. Gard. Herb.); rocky bottom of Quenebang River, Sturbridge, alt. 540 ft., 23 July, 1899, *Harper* (Gray Herb.); Uxbridge, 31 August, 1907, *Eaton* (Mo. Bot. Gard. Herb.).

Franklin Co.: Ashfield Pond, Ashfield, 18 July, 1909, *Williams* (Gray Herb.).

Berkshire Co.: Lake Undine, Mt. Everett, 1 October, 1897, *N.*

L. Britton (N. Y. Bot. Gard. Herb.); same station and date, *E. G. Britton* (N. Y. Bot. Gard. Herb.); Spectacle Pond, Sandisfield, 29 June, 1912, *Hoffman* (Gray Herb.); Lake Undine, The Dome, Sheffield, 27 August, 1902, *Hoffman* (Gray Herb.).

Massachusetts, but not located on map: "Country Pond," 18 August, 1896, *Eaton 441* (Mo. Bot. Gard. Herb.); "Kenoza Lake," 12 September, 1897, *Eaton 913* (Mo. Bot. Gard. Herb.); Pinkapog Pond, 27 August, 1869, *Boott* (N. Y. Bot. Gard. Herb.).

Connecticut: Greystone, 30 August, 1907, *Eaton* (Mo. Bot. Gard. Herb.); upper end Selden's Creek, 5 August, 1905, *Graves 142* (Mo. Bot. Gard. Herb.); Mashapang Pond, Union, 20–25 August, 1902, *Bissell* (Mo. Bot. Gard. Herb.); Lyme, 13 August, 1900, *Graves* (Mo. Bot. Gard. Herb.); Selden's Cove, Lyme, 29 August, 1901, *Bissell* (Gray Herb.); Selden's Cove, Lyme, 29 August, 1901, *Graves* (Mo. Bot. Gard. Herb.); submerged on sandy bottom, Selden's Cove, Lyme, 11 September, 1902, *Graves 1* (Gray Herb.); W. Goshen, July, 1891, *Underwood* (Mo. Bot. Gard. Herb. and Gray Herb.); Great Brook near Poquonnock, "Lake Marshapog, Litchfield," 1882, *Underwood* (Mo. Bot. Gard. Herb.); shallow water of pond at Graystone, Plymouth, 6 September, 1903, *Bissell* (in part) (Gray Herb.); Graystone, 30 August, 1907, *Eaton* (Mo. Bot. Gard. Herb.).

New York: Niagara River, below Buffalo, 3 September, 1866, *Clinton* (Mo. Bot. Gard. Herb. and Gray Herb.); Niagara River, September, 1866, *Clinton* (Gray Herb. and N. Y. Bot. Gard. Herb.); Oneida Lake, *Gilbert* (Mo. Bot. Gard. Herb.); Niagara River, below Buffalo, 1865, *Clinton* (N. Y. Bot. Gard. Herb.); at outlet of Lake Luzerne, Warren Co., 24 August, 1867, *Clinton* (Mo. Bot. Gard. Herb.); lake on Catskill Mts., July, 1868, *Canby* (Mo. Bot. Gard. Herb.); lakelet, Catskill Mts., 19 September, 1866, *Clinton* (Mo. Bot. Gard. Herb. and Gray Herb.); west of Lake George, shallow pool, 20 July, 1862, *Les Lesquereux* (Mo. Bot. Gard. Herb.); Niagara River, 2 September, 1862, *Clinton* (Mo. Bot. Gard. Herb.); submerged banks, Oneida Lake, 20 July, 1879, *Paine* (Mo. Bot. Gard. Herb.); Greenwood Lake, Orange Co., 15

July, 1876, *Schrenk* (Mo. Bot. Gard. Herb.); Southern Pond, Catskill Mts., 1866, *Clinton* (Gray Herb.); Catskill Lake, June, 1888, *Canby* (Mo. Bot. Gard. Herb.); submerged on east shore of Cayuta Lake, Schuyler Co., 23 August, 1893, *Clinton* (U. S. Nat. Herb.); Lake Tear of the Clouds, Mt. Marcy, 6 September, *Britton* (N. Y. Bot. Gard. Herb.); Lake Mahopac, 4 October, 1891, *Morong* (N. Y. Bot. Gard. Herb.); Upper Ausable Pond, Adirondacks, 3 September, 1894, *Britton* (N. Y. Bot. Gard. Herb.); on sand bottom, Lake Placid, 6 September, 1896, *Dr. & Mrs. Britton* (N. Y. Bot. Gard. Herb.); Clear Lake, south of Elk Lake, Adirondacks, 4 September, 1894, *Britton* (N. Y. Bot. Gard. Herb.); Chilson Lake, 31 August, 1900, *Dr. & Mrs. Britton* (N. Y. Bot. Gard. Herb.); Cinnamon Lake, Steuben Co., 31 August, 1898, *Barber 394* (Mo. Bot. Gard. Herb.); submerged on sandy bottom, Duck Lake, Conquest, Cayuga Co., 1 July, 1916, *Eames, Metcalf & Wiegand 5445* (Gray Herb.).

New Jersey: submerged on sandy bottom, Budd's Lake, Morris Co., 2 September, 1904, *Mackenzie 1025* (Mo. Bot. Gard. Herb.); shores of Tom's River, Ocean Co., 18 September, 1873, *Parker* (Gray Herb.); submerged in salt water, Tom's River, Ocean Co., 18 September, 1873, *Martindale* (Mo. Bot. Gard. Herb.); bed of Tom's River, Ocean Co., 16 September, 1867, *Parker* (Mo. Bot. Gard. Herb. and Gray Herb.); submerged, Tom's River, Ocean Co., 17 September, 1867, *Smith* (Mo. Bot. Gard. Herb.); growing abundantly on submerged sand bars, in Tom's River, 15 September, 1867, *Smith* (Gray Herb.); Lake Hopotong, Morris Co., 25 September, 1869, *Porter 1953* (Mo. Bot. Gard. Herb.); Ridgewood, 21 July, 1880, *Brown* (Mo. Bot. Gard. Herb.).

Pennsylvania: Great Pond, Pocono Mt., Carbon Co., 7 August, 1867, *Canby* (Mo. Bot. Gard. Herb.); Great Lake, Carbon Co., 7 August, 1867, *Porter* (Mo. Bot. Gard. Herb.); Montrose, Susquehanna Co., 24 May, 1869, *Garber* (Mo. Bot. Gard. Herb.); Presque Isle, Erie, September, 1868, *Garber* (Mo. Bot. Gard. Herb.); Erie, July, 1868, *Garber* (Gray Herb.); Presque Isle, Erie, 28 July, 1868, *Garber* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); Delaware R. at Monroe, Bucks Co., 24 July, 1886, *Ruth* (Univ. Minn. Herb.); Bowman's Pond, Wyoming, 17 July, 1897, *Brown*

(U. S. Nat. Herb.); Poyntelle Pond, Wayne Co., 20 and 21 July, 1900, *Clute* (Mo. Bot. Gard. Herb.); Coxtown Pond, Wayne Co., 20 July, 1900, *Clute* (Mo. Bot. Gard. Herb.).

Ontario: Partridge Lake, 50 mi. northeast of Bellesville, Hastings, 21 August, 1863, *John Macoun* (Mo. Bot. Gard. Herb.); Hastings, 12 July, 1870, *John Macoun* (Mo. Bot. Gard. Herb.); head of ship canal, Sault Ste. Marie, 7 August, 1869, *John Macoun* (Mo. Bot. Gard. Herb.); in Lake Superior, shores of Michipicoten Isl., at Grierson's Landing, 24 July, 1869, *John Macoun* (Mo. Bot. Gard. Herb.); water, Nipigon River, 21 July, 1884, *John Macoun* (Gray Herb. and N. Y. Bot. Gard. Herb.); on gravel bottom, Orient Bay, Lake Nipigon, midway of east shore of bay, in 2 ft. water, 23 July, 1911, *O. E. & G. K. Jennings 6582* (Gray Herb. and U. S. Nat. Herb.); marshes, Lake Nipigon, 10 July, 1884, *John Macoun* (Gray Herb.); Nipigon River, 23 July, 1884, *John Macoun 14222* (Gray Herb. and N. Y. Bot. Gard. Herb.); mouth of Nipigon River, Lake Superior, 23 June, 1884, *John Macoun* (N. Y. Bot. Gard. Herb.); Catfish Lake, Algonquin Park, 23 July, 1900, *John Macoun 24942* (N. Y. Bot. Gard. Herb.); Opeonga Lake, Algonquin Park, 16 August, 1900, *John Macoun 24940* (N. Y. Bot. Gard. Herb.).

Michigan: Belle Isle, Detroit River, 6 August, 1871, *Gillman* (Mo. Bot. Gard. Herb.); Gogebic Co., summer, 1919, *Darlington* (Mo. Bot. Gard. Herb.).

Ohio: submerged in 10–20″ water, Brady's Lake, Portage Co., 15–30 June, 1913, *Hopkins* (U. S. Nat. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.).

Wisconsin: Plum Lake, Sayner, Vilas Co., summer 1918, *Goodspeed* (Mo. Bot. Gard. Herb.); muddy shore, Three Lakes. Oneida Co., 13 August, 1918, *Hoffman* (Mo. Bot. Gard. Herb.); rocky bottom, Crooked Lake, Three Lakes, Oneida Co., 26 August, 1918, *Hoffman* (Mo. Bot. Gard. Herb.).

Minnesota: Mountain Lake, Cook Co., 21 August, 1901, *MacMillan, Brand & Lyon 177* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); small lake on Gunflint trail near 13 mile post, Cook Co., 14 August, 1901, *MacMillan, Brand & Lyon 71* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); Mud Lake, Cook Co., 20 August, 1901, *MacMillan, Brand & Lyon 70* (Mo. Bot. Gard. Herb.); Echo Lake, Mahtomedi, 14

August, 1902, *Wheeler 1227* (Univ. Minn. Herb.); Echo Lake, 16 August, 1904, *Lyon 874, 875, & 876* (Univ. Minn. Herb.); South Lake, Cook Co., 19 August, 1901, *MacMillan, Brand & Lyon 146* (Univ. Minn. Herb.); Mud Lake, Cook Co., 22 August, 1901, *MacMillan, Brand & Lyon 198* (Univ. Minn. Herb.); Kove Lake, Cook Co., 20 August, 1901, *MacMillan, Brand & Lyon 171* (Univ. Minn. Herb.); Mud Lake, Cook Co., 20 August, 1901, *MacMillan, Brand & Lyon 170* (Univ. Minn. Herb.); Long Lake, Vermilion Lake, Lat. 48°, 25 July, 1886, *Arthur, Bailey & Holway B413* (Univ. Minn. Herb. and Gray Herb.); Vermilion Lake, 18 July, 1886, *Arthur, Bailey & Holway B 87* (Univ. Minn. Herb. and Gray Herb.).

Idaho: Bitter Root Forest Reserve, alt. 1800 m., 1 September, 1897, *Leiberg 71* (Mo. Bot. Gard. Herb.); Bitter Root Forest Reserve, Head of Bear Creek, alt. 2250 m., 1 September, 1897, *Leiberg 2971* (U. S. Nat. Herb.).

Colorado: Seven Lakes, 3500 m., 1 September, 1902, *R. E. & E. S. Clements 493,1* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Gray Herb.).

Utah: lake near head of Bear River, Uintah Mts., 4 August, 1869, *Watson 1371* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and N. Y. Bot. Gard. Herb.).

Vancouver Island: Prospect Lake near Victoria, 25 July, 1908, *John Macoun 86379* (Gray Herb. and N. Y. Bot. Gard. Herb.); Alberni, 10 August, 1887, *John Macoun 14217* (Gray Herb.); Sproat Lake, 12 August, 1887, *John Macoun 14218* Gray Herb.); Sooke, 2 August, 1893, *John Macoun 14215* (Gray Herb.); Sooke, 2 August, 1893, *John Macoun 532* (Mo. Bot. Gard. Herb.); salt marsh, Somas River, 2 August, 1887, *John Macoun 14216* (Gray Herb.); in mud, Somas River, Alberni, with Limosella and Lilaea, 20 June, 1916, *Henry 9082* (Gray Herb.).

Washington: shallow ponds, alt. 6000 ft., Chiquash Mts., Skaimania Co., 16 August, 1900, *Suksdorf 2210* (Mo. Bot. Gard. Herb.); in lake, alt. 5000 ft., Mt. Rainier, August, 1895, *Piper 2131* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.); (lake 2 ft. deep volcanic ash) Mirror Lake, Mt. Rainier, 23 August, 1901, *Flett 1929x* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and U. S. Nat. Herb.);

Reflection Lake, Mt. Rainier, 20 July, 1907, *Cowles 776* (Mo. Bot. Gard. Herb.); Lake Chelan, 22 September, 1897, *Gorman 715* (Gray Herb.); in Bitter Lake, near Seattle, July, 1891, *Piper 1117* (N. Y. Bot. Gard. Herb.).

California: at alt. 8000 ft., Mountain Lakes, head of Trinity River, 1 September, 1882, *Pringle* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Gray Herb.); Castle Lake (near Scott's Mountain), mountains about headwaters of Sacramento River, scattered in gravelly bottom in 2–6 ft. water, 14 August, 1881, *Pringle* (Mo. Bot. Gard. Herb. and Gray Herb.).

42a. Forma robusta Pfeiffer, comb. nov.

I. echinospora var. *robusta* Engelm. Trans. St. Louis Acad. Sci. 4: 380. 1882.

I. echinospora Braunii f. *robusta* Clute, Fern Allies, 221, 258. 1905.

I. Gravesii Eaton, Fernwort Papers, 14. 1900.

I. valida var. *Gravesii* Clute, Fern Allies, 343. 1905.

Stouter than the species, with leaves as numerous as 75, 12–15 cm. long; stomata usually numerous, more so than in the species.

Specimens examined:

Vermont: Lake Champlain, north end of Isle La Motte, 2 September, 1879, *Pringle* (Mo. Bot. Gard. Herb. and Gray Herb.), TYPE; Lake Champlain, 19 July, 1878, *Pringle* (Mo. Bot. Gard. Herb.).

Connecticut: Tyler's Pond, near the outlet, W. Goshen, August, 1883, *Underwood* (Mo. Bot. Gard. Herb.); Tyler's Pond, W. Goshen, August, 1889, *Underwood & Cook* (N. Y. Bot. Gard. Herb.); gravelly and sandy tidal shores, Selden's Cove, Lyme, 31 August, 1900, *Graves* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); same, *Graves 145* (Mo. Bot. Gard. Herb.); submerged, growing in mud, Selden's Cove, Lyme, 29 August, 1901, *Graves* (Mo. Bot. Gard. Herb. and Gray Herb.); Selden's Cove, Lyme, 27 August, 1907, *Eaton* (Mo. Bot. Gard. Herb.); shallow water of pond at Graystone, Plymouth, 6 September, 1903, *Bissell* (Mo. Bot. Gard. Herb. and Gray Herb.); Bristol, 1888, *Bishop* (U. S. Nat. Herb.);

Stratford, plentiful locally in sandy gravel of tidal flats of Housatonic River, 29 September, 1919, *Eames 9671* (Gray Herb.).

Plants described by Eaton as *I. Gravesii* have the appearance of robust forms of *I. Braunii,* are similar in abundance of stomata, and appear like immature specimens in spore markings. In cases where mature spores have been found in the soil, they prove to have the spines characteristic of *I. Braunii,* as well as the size. This is true of the specimens reported above from Connecticut, all of which have been collected at about the same season of the year.

There is one other possible position for this Connecticut material, if the assumption that it is immature proves to be unfounded. Young megaspores of the echinate group have very much the appearance that all the spores of *I. Eatoni* Dodge show. In habit, this stout form is enough like the latter to suggest a possible connection in this direction. Experimental work and collections through a longer interval of the fruiting season should clear up this doubtful form.

42b. Var. **maritima** (Underw.) Pfeiffer, comb. nov.

I. maritima Underw. Bot. Gaz. **13**: 94. 1888.

I. echinospora var. *maritima* Eaton, Fern Bull. **13**: 52. 1905.

I. Macouni Eaton, Fern Bull. 8: 12. 1900.

Corm 2-lobed; leaves 7–15, 3–12 cm. long, green, chiefly slender, with fine-pointed tips and rather wide membranaceous border at base; stomata numerous; peripheral strands lacking; ligule triangular, little longer than wide; sporangia globose to oblong, 3–4 mm. long, with velum usually narrow, sometimes covering ½ of sporangium; megaspores white, chiefly 380–500 μ, rarely 600 μ, in diameter, usually densely marked with stout blunt spines, sometimes confluent into toothed ridges; microspores 30–39 μ long, chiefly papillose.

Distribution: Atkah and Vancouver Islands, Washington.

Specimens examined:

Aleutian Archipelago: pools in Atkah Isl., Behring Sea, 26 August, 1891, *Macoun 14227* (Mo. Bot. Gard. Herb. and Gray Herb.).

Vancouver Island: Alberni, Barclay Sound, August, 1887, *J. Macoun* (Mo. Bot. Gard. Herb.); Great Central Lake, 2 July,

1907, *Rosendahl 2050* (Mo. Bot. Gard. Herb., Gray Herb., U. S. Nat. Herb., and Univ. Minn. Herb.).

Washington: lake 2 ft. deep (volcanic ash), Mirror Lake, Mt. Rainier, 23 August, 1901, *Flett 1930* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.).

It seems possible that this is but a form of *I. Braunii* Dur. growing under rather hard conditions. The distinguishing features are the large microspores with their papillose markings, in contrast to the usual smooth *I. Braunii* spores of 35 μ or less; the more numerous stomata, which are probably due to greater exposure; and the narrow velum, a feature which is shared, however, by most western specimens of *I. Braunii*.

43. I. truncata Clute, Fern Allies, 222–223, 260. 1905.

I. echinospora var. *truncata* Eaton in Gilbert, List N. Am. Pterid. 10: 27. 1901.

Corm 2-lobed; leaves 20–40, 6–13 cm. long, stout, rather rigid, finely tapering, with almost setaceous apex and wide membranaceous margin at base; stomata numerous; peripheral strands lacking; ligule short-triangular; sporangium oblong, 4–6 mm. long, marked profusely with brown patches of sclerenchyma cells; velum covering about ¼–½ of sporangium; megaspores white, 430–520 μ, rarely 680 μ, in diameter, marked with numerous blunt spines; microspores 27–33 μ long, papillose.

Distribution: Alaska, Vancouver Island.

Specimens examined:

Alaska: Kodiak, 20 July, 1899, *Coville & Kearney Jr. 2336 & 2337* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.), TYPE; Kodiak, 20 July, 1899, *Fernow 2640* (Mo. Bot. Gard. Herb.).

Vancouver Island: Sproat Lake, *J. Macoun* (Mo. Bot. Gard. Herb.); Sproat Lake, fresh water, 13 August, 1887, *J. Macoun 5* (N. Y. Bot. Gard. Herb.).

Doubtful: *Coville & Kearney 386,* New Metlakatla, Annette Isl., Alaska, 4 June, 1899.

In the spinulose megaspores there is as wide a variation in size, number, and arrangement of spines as in *I. Braunii* Dur. with a marked tendency toward elongated, densely crowded, rather tuberculate structures. For the close arrangement the

only rival among the echinate forms is *I. Brochoni* Motel., in which the spines are far sharper.

Most of the Alaskan material is immature, but in some of the specimens mature spores can be found in the soil. The collection of Coville & Kearney 2336 appears to be made of smaller plants of the species, their 2337 of larger specimens, with no notable differences in spores, sculpture, etc.

Sect. 3. Cristatae

§ 3. Cristatae. Forms with 2 or 3-lobed corms; producing megaspores with tubercles or spines, somewhat extended into ridges, tending toward branching crests on basal face; microspores rough or smooth.

Key to Species

A. Corms 3-lobed.
  a. Leaves very slender ---- *44. I. tripus*
  b. Leaves stout, mucronate ---- *45. I. Savatieri*
B. Corms 2-lobed.
  a. Amphibious forms, with stomata; peripheral strands present or absent.
    α. Megaspores with very crowded prominences.
      I. Leaves numerous (25–200), usually with peripheral strands ---- *46. I. Eatoni*
      II. Leaves few (8–25), peripheral strands lacking ---- *47. I. saccharata*
    β. Megaspores with less densely crowded prominences.
      I. Sculpture consisting of spines somewhat extended to form jagged crests.
        1. Smaller form, leaves 10–30, 9–30 cm. long ---- *48. I. riparia*
        2. Larger form, leaves 15–75, 10–45 cm. long ---- *48a. I. riparia* var. *canadensis*
      II. Sculpture consisting of tubercles somewhat extended to form rounded ridges.
        1. Leaves long, more than 16 cm., with peripheral strands ---- *49. I. Pringlei*
        2. Leaves short, less than 8 cm., lacking peripheral strands ---- *50. I. Flettii*
  b. Submerged forms, lacking stomata and peripheral strands.
    α. Velum narrow, covering about ⅓ of sporangium.
      I. Megaspores with somewhat confluent, but little anastomosing, crests ---- *51. I. lacustris*
      II. Megaspores with crests, forming irregular network on basal face ---- *52. I. occidentalis*
    β. Velum wider, covering ⅓–⅔ of sporangium ---- *53. I. Piperi*

44. I. tripus A. Br. Monatsber. K. Akad. Wiss. Berlin, 544. 1868; Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 361. 1883.

I. phaeospora Dur. Bull. Soc. Bot. Fr. **9**: 103. 1864. *fide* Motel. & Vendr.

Calamaria tripus Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm conspicuously 3-lobed; bulb of leaves small, bound by the dark black remains of dying leaves; leaves very slender, not narrowed above, somewhat obtuse and tough, opaque; stomata present; peripheral strands absent (?); ligule elongate-deltoid; velum none (beyond the acute edge of the fovea); sporangium without border, pale, becoming dark ashy, beautifully marked with few schlerenchyma cells; megaspores 400–460 μ, dark when wet or dry, meandriform-roughened on all faces; microspores 35–40 μ long, dark with loose exospore, somewhat wing-crested.

Distribution: Swan River, Australia.

Description from Braun.

45. **I. Savatieri** Franchet, Bull. Soc. Bot. Fr. **31**: 395. 1884; Baker, Fern Allies, 133. 1887.

Calamaria Savatieri Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm obscurely 3-lobed, about 15–20 mm. in diameter; bulb coarse, 2–3 cm. in diameter, bearing loosely imbricated bases of leaves; leaves stout, subtetragonous, mucronate, about 20 cm. long in submerged forms, much shorter (hardly 6 cm.) in emersed plants, very coarse and rigid, broad (7–10 mm. at base), with wide membranaceous margin; sporangium small, hardly 4 mm. long, ovate or suborbicular, with narrow area; ligule ovate-deltoid, rough, fuscous; velum incomplete, covering 1/3–3/4 of sporangium; megaspores white, rough all over surface, marked finely with anastomosing ridges, more or less elevated; microspores brown, very finely muricate or almost smooth, cristate on one side.

Distribution: Patagonia, lakes in vicinity of Puerto Bono, Straits of Magellan.

Description from Franchet.

46. **I. Eatoni** Dodge, Ferns & Fern Allies of N. Eng. 39. 1896; Bot. Gaz. **23**: 32–39. *pl. 4–5.* 1897; Underwood, Native Ferns and Allies, 146. 1900.

I. valida Clute, Fern Allies, 236, 260. 1905.

Corm 2-lobed; leaves 25–200, 10–60 cm. in length, much shorter in summer (10–15 cm. long), coarser in spring forms; stomata numerous; peripheral strands variable in number, some-

times wanting; sporangia oblong, 6–11 mm. long, brown-spotted, 1/6–1/4 covered by velum; megaspores white, 396–520 μ, rarely more, in diameter, with irregular commissural ridges and with faces marked very irregularly by crowded short meandriniform elevations, sometimes with rounded teeth; microspores 25–35 μ long, smooth to slightly papillose.

Distribution: New Hampshire, Massachusetts, New Jersey.

Specimens examined:

New Hampshire: shore of pond, Trickling Falls, Kingston, August, 1895, *Dodge* (Mc. Bot. Gard. Herb. and Gray Herb.), TYPE; flats at Kingston, August, 1896, *Eaton* (Mo. Bot. Gard. Herb.); Kingston, 9 September, 1897, *Eaton* (Mo. Bot. Gard. Herb. and Gray Herb.); sloping bank of a pond, out of water most of the year, in mixed mud and sand, East Kingston, September, 1895, *Herb. Eaton* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); East Kingston, August, 1895, *Dodge* (Mo. Bot. Gard. Herb.); "East Kingston, on Powow River, shores of pond, fruiting out of water," 6 October, 1895, *Eaton* (Mo. Bot. Gard. Herb.); East Kingston, 26 July, 1896, *Eaton 351* (Mo. Bot. Gard. Herb.); East Kingston, August, 1896, *Dodge* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); East Kingston, 8 September, 1896, *Eaton 589* (Mo. Bot. Gard. Herb.); "The flats," East Kingston, 28 July, 1896, *Dodge* (Gray Herb.); East Kingston, August, 1896, *Eaton 163* (N. Y. Bot. Gard. Herb.); East Kingston, 9 September, 1897, *Eaton* (Mo. Bot. Gard. Herb.); East Kingston, 10 August, 1900, *Dodge* (Mo. Bot. Gard. Herb.); submersed, Kingston, August and September, 1897, *Eaton 898* (Mo. Bot. Gard. Herb.); grown in pond at Seabrook from plant collected at Kingston, 1900, *Eaton* (Mo. Bot. Gard. Herb.); West Epping, *Eaton 482C* (Mo. Bot. Gard. Herb.); Epping, 12 August, 1896, *Eaton 427* (Mo. Bot. Gard. Herb.); Lamprey River, Epping, August, 1897, *Eaton* (Mo. Bot. Gard. Herb.); Newmarket, 19 August, 1899, *Eaton 217* (Mo. Bot. Gard. Herb.).

Massachusetts: Tuxbury's Pond, Amesbury, 19 September, 1898, *Eaton 919* (Mo. Bot. Gard. Herb.); Parker River, *Dodge* (Mo. Bot. Gard. Herb.); Long Pond, North Easton, 23 September, 1903, *Eaton* (Mo. Bot. Gard. Herb.); without

location, September 16, 1902, *Eaton* (Mo. Bot. Gard. Herb.).

New Jersey: Morris Pond, 11 September, 1890, *Britton* (N. Y. Bot. Gard. Herb.); in water 1 ft. deep, Morris Pond, 14 September, 1887, *Britton* (N. Y. Bot. Gard. Herb.).

47. **I. saccharata** Engelm. in Gray, Manual, ed. 5, 676. 1867; Baker, Jour. Bot. 18: 69. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 356. 1883; Engelm. Trans. St. Louis Acad. Sci. 4: 382. 1882; Eaton in Gray, Manual, ed. 7, 60. 1908; Maxon in Britton and Brown, Ill. Fl. 1: 52. 1913.

I. saccharata var. *Palmeri* Eaton, Proc. Biol. Soc. Wash. 14: 49. 1901.

I. saccharata var. *reticulata* Eaton, Proc. Biol. Soc. Wash. 14: 49. 1901.

Calamaria saccharata Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed, small, much flattened; leaves 8–25, rarely 40, 6–15 cm. long, slender, curved, olive-green, with membranaceous margin at base, soon disappearing above; stomata numerous; peripheral strands none; ligule small, cordate at base; sporangium small, 3–5 mm. long, almost as wide as long, with narrow velum (covering less than 1/5 of sporangium); megaspores white, 400–520 μ in diameter, marked with very irregular, crowded, more or less discontinuous ridges with prominences somewhat blunt or granular; microspores 23–29 μ long (rarely 32), almost smooth.

Distribution: Delaware, Maryland, District of Columbia, Virginia.

Specimens examined:

Delaware: near Seaford, shores of Nanticoke River, Sussex Co., August, 1874, *Canby* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.).

Maryland: on tidal mud, Salisbury, shores of Wicomico River, 28 August, 1867, *Canby* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.), TYPE; shores of Wicomico River below Salisbury, 8 September, 1866, *Canby* (Mo. Bot. Gard. Herb. and Gray Herb.); tidal mud, Salisbury, 28 August, 1867, *Canby* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); shore of Wicomico River near Salisbury, 1 September, 1867, *Canby* (Gray Herb.); gravelly shore of Wicomico River, Salisbury, 1 Oc-

tober, 1868, *Commons* (U. S. Nat. Herb. and Gray Herb.); Salisbury, 1869, *Canby* (Mo. Bot. Gard. Herb.); "Maryland," September, 1870, *Canby* (Gray Herb.); Notley Hall, 1894, *Coville 32* (Gray Herb., U. S. Nat. Herb., and N. Y. Bot. Gard. Herb.); Wicomico River, 14 September, 1895, *Palmer* (Mo. Bot. Gard. Herb.); Kent Co., Lloyd's Creek, Sassafras River, 12 August, 1895, *Palmer* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); same, 29 July, 1896 (Mo. Bot. Gard. Herb.); tidal track, reddish sand, capped lightly with mud, Elk River (about 80 mi. north of Nanticoke and Wicomico River), 1894, *Palmer* (Mo. Bot. Gard. Herb.); Town Point, Elk River, 30 July, 1896, *Palmer* (Mo. Bot. Gard. Herb.); Cabin Johns Creek, 21 July, 1896, *Palmer* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Cabin Johns Creek, Elk River, 31 July, 1896, *Palmer* (U. S. Nat. Herb.); between tides, rather common among rocks in sand, ½ mi. southwest of Havre de Grace, 19 July, 1902, *Shull 66* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); ¼ mi. south of Havre de Grace, 19 July, 1902, *Shull 67* (U. S. Nat. Herb.); mouth of Gunpowder River, 2 September, 1902, *Shull 296* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); 1/3 mi. above mouth of Little Gunpowder River, in sand, 3 September, 1902, *Shull 305* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.).

Washington, D. C.: shores of Anacostia River, opposite Navy Yard, 1 September, 1900, *Steele* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.); tide mud, 5 August, 1898, *Steele* (Gray Herb.).

Virginia: Hunting Creek, by bridge near its mouth, 22 July, 1888, *Vasey & Coville* (U. S. Nat. Herb.); shore of Potomac at the foot of the Mt. Vernon estate, 4 July, 1889, *Coville* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Hunting Creek, 1 mi. south of Alexandria, 7 September, 1901, *Maxon 432* (U. S. Nat. Herb.); 1 mi. south of Alexandria, at right hand of wagon bridge over Hunting Creek, an arm of the Potomac, in sand or gravel, in 6 in. water, exposed at ebb tide, 16 September, 1906, *Maxon 3886* (U. S. Nat. Herb.); Hunting Creek, southwest of Alexandria, 11 August, 1902, *Shull 200, 201* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); near Hunting Creek, southwest of Alexandria, in shallow

water, 11 August, 1902, *Shull 201* (Gray Herb.); so. margin Four Mile Run, 19 November, 1895, *Coville 123* (U. S. Nat. Herb.); tide beach in mud and gravel, mouth of Four Mile Run between Washington and Alexandria, 5 August, 1898, *Steele* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Four Mile Run, 4 mi. south of Washington, D. C., 22 August, 1902, *Shull 252* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Four Mile Run, near Alexandria, abundant between tidal limits, 12 July, 1905, *Ivar Tidestrom* (Gray Herb.); Hunting Creek, Alexandria, 13 August, 1910, *Dowell 6455* (U. S. Nat. Herb.).

48. I. riparia Engelm. A. Br. in Flora (Regensb. Bot. Zeit.) **29**: 178. 1846; Am. Jour. Arts and Sci. **3**: 52. 1847; Baker, Jour. Bot. **18**: 69. 1880; Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 368. 1883; Engelm. Trans. St. Louis Acad. Sci. **4**: 382. 1884; Macoun, Cat. Canad. Pl. pt. 4: 293. 1888; Eaton in Gray, Manual, ed. 7, 60. 1908; Maxon in Britton and Brown, Ill. Fl., ed. 2, 52. 1913.

Calamaria riparia Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed; leaves 10–30, 9–30 cm. long, rather rigid, more slender than *I. lacustris*, deep green in color, with membranaceous margins but briefly extended; stomata numerous; peripheral strands lacking; ligule elongated, with narrow tip, ovate at base; sporangia spotted with brown cells, oblong, 4–7 mm. long, with narrow velum (covering sporangia 1/4–1/3); megaspores white, 440–660 μ in diameter, marked with conspicuous jagged crests, often with isolated peaks standing out sharply, sometimes anastomosing slightly; microspores cream-colored in mass, 25–33 μ long, tuberculate.

Distribution: southern Canada, New England, south to Delaware and Pennsylvania.

Specimens examined:

Canada: Crow River, northwest of Belleville, Hastings Co., 18 July, 1864, *Macoun* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.).

Maine: Cornish, 1859, *Chickering 7* (Mo. Bot. Gard. Herb.).

Connecticut: Lantern Hill Pond, North Stonington, 23 July, 1901, *Graves & Bissell* (Mo. Bot. Gard. Herb.); Lantern Hill Pond, North Stonington, 23 July, 1901, *Bissell* (Gray

Herb.); abundant in mill-race and stiller waters of Mill River, near tide water, local, Fairfield, 5 September, 1897, *Eames* (Gray Herb.).

Vermont: in Connecticut River near Brattleborough, from foot deep to an inch or less (in fall when river recedes), on a pebbly bottom where the mud is deposited between the rocks, 1866, *Frost 6* (Mo. Bot. Gard. Herb.); Lake Bomoseen, W. Hubbardton, 3 October, 1897, *Eggleston 1786* (Gray Herb. and N. Y. Bot. Gard. Herb.); above low water line, region Lake Bomoseen, Castleton, 5 September, 1909, *Dutton 232* (Gray Herb.).

Massachusetts: Uxbridge, 1831, *Robbins 7* (Mo. Bot. Gard. Herb.); Uxbridge, 1843, *Robbins 8* (Mo. Bot. Gard. Herb.); Uxbridge, without date, *Robbins 9* (Mo. Bot. Gard. Herb.); Uxbridge, 1848, *Robbins 11* (Mo. Bot. Gard. Herb.); Uxbridge, 30 August, 1866, *Robbins 14* (Mo. Bot. Gard. Herb.); Uxbridge, in a mill pond, 1865, *Robbins* (Mo. Bot. Gard. Herb.); very shallow part of a cool pond (Capron's reservoir), 4 September, 1869, *Robbins* (N. Y. Bot. Gard. Herb.); small cold pond (Capron's fountain), 6 October, 1867, *Robbins* (N. Y. Bot. Gard. Herb.); Uxbridge, 1866, *Robbins* (N. Y. Bot. Gard. Herb.); some entirely submerged and some in mud on shore, South Natick, 25 June, 1879, *Morong* (N. Y. Bot. Gard. Herb.); ponds, Amherst, September, 1874, *Jesup* (Mo. Bot. Gard. Herb.); shallow water, So. Natick, September, 1878, *Morong* (Mo. Bot. Gard. Herb.); Taunton, Watson's Pond, 15 September, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Uxbridge, 31 August, 1907, *Eaton* (Mo. Bot. Gard. Herb.); Shawshim River, Bedford, 25 August, 1884, *Jenks & Swan* (Mo. Bot. Gard. Herb. and Gray Herb.); Neponset River, Paul's Bridge, *Faxon* (Gray Herb.); Bedford, without date, *Swan* (Gray Herb.).

New Jersey: muddy banks of the Delaware River, Camden, September, 1860, *D. C. Eaton* (Mo. Bot. Gard. Herb.); along shores of the Passaic River, 6 mi. north of Newark, August, 1858, *Ennis* (Mo. Bot. Gard. Herb.); banks of the Delaware, above Camden, 1867 (?), *Durand* (Gray Herb.); shores of the Delaware, 22 September, 1866, *Parker* (Mo. Bot. Gard. Herb.); gravelly shore of the Delaware River, between high and low water mark, Camden, 20 September, 1867, *without*

collector (Mo. Bot. Gard. Herb.); margin of the Delaware, opposite Philadelphia, October, 1868, *ex. herb. Thurber* (Gray Herb.); shore of the Delaware, between high and low water mark, Camden, 7 October, 1877, *Parker* (Gray Herb.); Fish House, Delair, 19 August, 1906, *Poyser* (Mo. Bot. Gard. Herb.).

Delaware: shores of the Delaware River, 4 mi. above Wilmington, July, 1860, *Canby* (Mo. Bot. Gard. Herb.); shores of the Delaware, near low water mark, Newcastle Co., 1862, *Canby* (Mo. Bot. Gard. Herb.); shores of the Delaware River near Wilmington, 1865, *Canby* (Gray Herb.); Wilmington, 29 June, 1866, *Canby* (Gray Herb.); banks of the Delaware, between high and low water mark, 14 September, 1866, *Commons* (Mo. Bot. Gard. Herb.); Wilmington, 25 September, 1866, *Canby* (Gray Herb.); gravelly shores, Delaware River, between high and low water mark, near Wilmington, 11 July, 1866, *Commons* (Mo. Bot. Gard. Herb.); muddy shores of the Delaware River near Wilmington, August, 1867, *Canby* (Mo. Bot. Gard. Herb.); Wilmington, 12 June, 1867, *Canby* (Mo. Bot. Gard. Herb.); Wilmington, 1882, *Canby* (Mo. Bot. Gard. Herb.); river shore below Claymont, 22 June, 1886, *Commons* (Mo. Bot. Gard. Herb. and Gray Herb.); Delaware River, 1905, *Palmer* (Mo. Bot. Gard. Herb.).

Pennsylvania: inundated by tides, shores of Delaware River, Gibsonville (Philadelphia), 22 August, 1815, *Nuttall* (Mo. Bot. Gard. Herb.); Philadelphia, without date, *Eaton ex. herb. Thurber* (Gray Herb.); gravelly shore of the Delaware, near Philadelphia, August, 1844, *Zantziger* (Mo. Bot. Gard. Herb.), TYPE; Philadelphia, October, 1848, *Durand* (Mo. Bot. Gard. Herb.); banks of the Delaware, Philadelphia, July, 1860, *James* (Mo. Bot. Gard. Herb.); tidal mud, Tinicum to 11 mi. below Philadelphia, August, 1864, *Smith* (Mo. Bot. Gard. Herb.); banks of Delaware River near Philadelphia, 18 June, 1866, *Durand* (Mo. Bot. Gard. Herb. and Gray Herb.); Delaware River, August, 1894, *Palmer* (Mo. Bot. Gard. Herb.); banks of Lehigh River, on an island near Bethlehem, in sandy mud of river among and between stones, 1866, *Durand* (Mo. Bot. Gard. Herb. and Gray Herb.); along shaded bank of Lehigh River near Beth-

lehem, August, 1882, *Rau* (Mo. Bot. Gard. Herb.); gravelly banks, tidal margin of the Delaware, opposite Chester, August, 1894, *Palmer* (Mo. Bot. Gard. Herb.); shores of Delaware, opposite Chester, 22 August, 1896, *without collector* (U. S. Nat. Herb.); shores of Delaware, opposite Chester, 1 August, 1896, *Palmer* (Mo. Bot. Gard. Herb.).

48a. Var. **canadensis** Engelm. Trans. St. Louis Acad. Sci. 4: 383. 1884.

I. Dodgei Eaton, Fern Bull. 6: 6. 1898.

I. Dodgei var. *Robbinsii* Eaton, Rhodora 10: 42. 1908.

I. canadensis Eaton, Proc. U. S. Nat. Mus. 23: 650. 1901; Bull. Torr. Bot. Club 30: 359–362. 1903.

I. canadensis var. *Robbinsii* Eaton, Rhodora 5: 7. 1903.

Usually larger than the species; leaves 15–75, 10–45 cm. long, with rather prominent membranaceous margins; stomata numerous; peripheral strands variable (2–4) or lacking; ligule cordate at base, subulate; sporangia 5–8 mm. long, partly covered by velum (¼–½); megaspores white, 440–650 μ in diameter, with usually scattered, thin, spiny crests, brief and discontinuous, though sometimes anastomosing, particularly on the basal face; microspores 27–37 μ long, minutely roughened to decidedly spinulose.

Distribution: eastern Canada, Massachusetts, Connecticut.

Specimens examined:

Canada: Petites Chaudiéres, near Ottawa, emersed, 11 August, 1917, *Bro. Rolland 6230* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); Brigham's Creek, Hull, 29 August, 1894, *Macoun 14213* (Gray Herb.); near Hull, 4 October, 1907, *Macoun 76921* (Gray Herb. and N. Y. Bot. Gard. Herb.); Ottawa River below railway bridge, Hull, 18 August, 1911, *Macoun 84084* (Gray Herb. and N. Y. Bot. Gard. Herb.); mud in places that had been overflowed in spring, Hull, October, 1890, *Macoun* (N. Y. Bot. Gard. Herb.).

New Hampshire: Kingston, 26 July, 1896, *Eaton 351* (Mo. Bot. Gard. Herb.); Kingston, 28 July, 1896, *Eaton 362* (Mo. Bot. Gard. Herb.); East Kingston, 9 September, 1897, *Eaton 900* (Mo. Bot. Gard. Herb.); flats of Powow River, Trickling Falls, Kingston, 28 July, 1896, *Eaton* (Mo. Bot. Gard.

Herb.); Kingston, September, 1897, *Eaton 942* (Mo. Bot. Gard. Herb.).

Massachusetts: Uxbridge, 1845, *Robbins 10* (Mo. Bot. Gard. Herb.); Watson's Pond, Taunton, 15 September, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Leach's Pond (Wilbor's Pond), (Mass.?), September, 1906, *Eaton* (Mo. Bot. Gard. Herb.); Uxbridge, 31 August, 1907, *Eaton* (Mo. Bot. Gard. Herb.); rare, muddy shores, pool in Peabody Cemetery, 10 October, 1915, *Andrews* (Gray Herb.).

Connecticut: half submerged on shore of Chapman's Pond, Groton, 30 August, 1896, *Graves 144* (Mo. Bot. Gard. Herb.); mill-race in Mill River, Fairfield, 19 July, 1905, *Eames 5294* (Gray Herb.).

New Jersey: Pt. Pleasant, September, 1899, *Best* (Mo. Bot. Gard. Herb.); Pt. Pleasant, 4 July, 1899, *Best & Crawford* (Mo. Bot. Gard. Herb.).

The species and the variety are very close; the distinction is based chiefly on the tendency to larger size in the variety which is evinced in more and longer leaves. There is also an inclination toward larger microspores, though the ranges overlap sufficiently so that this too cannot be used absolutely. The Uxbridge material of Robbins is of the intermediate sort, with somewhat bigger microspores, but plant size according well with the general range of the species.

49. I. Pringlei Underw. Zoe 1: 98. 1890.

Corm 2-lobed; leaves 4–20, 16–30 cm. long, firm, fine, tapering, with membranaceous margin only briefly extended (1 cm.) above level of the sporangium; stomata abundant; peripheral strands numerous, 6 conspicuous and 6–10 accessory groups; ligule triangular, short and wide; sporangium large, up to 10–12 mm. in length in large individuals, partly covered by narrow velum; megaspores chalky white when dry, tan when moist, 460–550 μ in diameter, rarely 650 μ, marked with high tubercles, occasionally extended into brief rounded crests; commissural ridges irregular in outline; microspores fawn-colored, 35–42 μ long, sometimes showing tendency toward winged condition.

Distribution: Mexico.

Specimens examined:

Mexico: in grassy springy places near Guadalajara, State of

Jalisco, 1 November, 1890, *Pringle 3333* (Mo. Bot. Gard. Herb., Gray Herb., and U. S. Nat. Herb.).

50. I. Flettii Pfeiffer, comb. nov.

I. echinospora var. *Flettii* Eaton, Fern Bull. **11**:85. 1903. (name only); Eaton, Fern Bull. **13**: 51. 1905.

Corm 2-lobed; leaves 15–30, 5–8 cm. long, coarse, tapering, spreading or recurved, with wide basal sheath extending upward one-third of leaf length; stomata present; peripheral strands lacking; ligule blunt triangular; sporangia oblong, 4 mm. long, with velum developed less than half; megaspores 480–570 μ in diameter, marked with coarse low tubercles and short crests, usually somewhat distant; microspores 29–33 μ long, finely spinulose.

Distribution: Washington.

Specimens examined:

Washington: Spanaway Lake, Pierce Co., August, 1895, *Piper 2125* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); shore, Spanaway Lake, 17 September, 1899, *Allen* (N. Y. Bot. Gard. Herb.); amphibious, lake shore in gravel, Spanaway Lake, 7-8 October, 1899, *Flett 949* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.), TYPE; submerged, above in driest season, Spanaway Lake, 22 September, 1900, *Flett* (N. Y. Bot. Gard. Herb.); Spanaway Lake, under water, 20 May, 1911, *Bardell* (U. S. Nat. Herb.); Spanaway Lake, under water, 20 May, 1911, *Zeller* (U. S. Nat. Herb.).

51. I. lacustris L. Sp. Pl. 1100. 1753; Baker, Jour. Bot. **18**: 67. 1880, and Fern Allies, 125. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 325. 1883.

I. leiospora Klinggräff. Schr. Nat. Ges. Danzig 6[1]: 20. 1884.

Calamaria lacustris Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed; leaves 8–40, 8–18 cm. in length, quadrangular in cross-section, erect, coarse, acutely pointed, dark green, with membranaceous border very wide at base, but not greatly prolonged beyond level of the sporangium; stomata and peripheral strands lacking; ligule usually short, triangular; sporangia 4–7 mm. long, with narrow velum; megaspores white, 500–700 μ in diameter, marked with numerous somewhat confluent, but little

anastomosing crests; commissural ridges irregular; microspores yellow-brown, 31–45 μ long, smooth.

Distribution: British Isles, north and central Europe.

Specimens examined:

British Isles:

Scotland: Loch Brandy, Clova, *Croall 1418* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); Loch Callater, Aberdeenshire, July, 1856, *Croall* (U. S. Nat. Herb.); Loch Cluny, Perthshire, September, 1850, *Walker-Arnott* (N. Y. Bot. Gard. Herb.); "Scotland," *Ward* (N. Y. Bot. Gard. Herb.); Loch Brandy, Forfarshire, August, 1837, *Brand* (*Soc. Bot. Edin. 183*) (N. Y. Bot. Gard. Herb.); Loch Brandy, Clova, August, 1837, *Balfour* (N. Y. Bot. Gard. Herb.); in a little lake near the Trossach's toward Callander, July, 1871, *without collector* (Gray Herb.); Loch Lomond, without date or collector (Gray Herb.).

Wales: Llanberis, 10 June, 1870, *Butter* (Mo. Bot. Gard. Herb.); Lake Llyn Padark, 20 August, 1862, *Gay* (Gray Herb.); Crôm y glo, North Wales, 12 November, 1862, *Gay* (?) (Mo. Bot. Gard. Herb. and Gray Herb.); Phrynon Vrech, 23 August, 1862, *without collector* (Mo. Bot. Gard. Herb.).

France: Lac de Gerardmer, Vosges, 16 July, 1858, *Cosson* (Mo. Bot. Gard. Herb.); Lac de Guéry, Puy-de-Dôme, 23-24 August, 1861, *Durieu* (Mo. Bot. Gard. Herb.); Lac de Guéry, 24 August, 1861, *Gay* (Gray Herb.); Lac de Guéry, Puy-de-Dôme, August, 1890, *Hy* (Mo. Bot. Gard. Herb.); Lac de Gerardmer, 15 October, 1856, *Jacquel* (Mo. Bot. Gard. Herb.); Lac de Guéry au Mont Dore, 16 August, 1877, *Allard* (U. S. Nat. Herb.); Lac de Gerardmer, near St. Dié, at bottom of water on granitic soil, 25 September, 1851, *Billot* (U. S. Nat. Herb.); in Lake Gerardmer, August, 1864, *Perrin* Gray Herb. and N. Y. Bot. Gard. Herb.); mountain lake, Chauvet, in Arvernia, 27 August, 1861, *Gay* (Gray Herb.); Lac de Bruyères, dans les Vosges, *Hornung* (N. Y. Bot. Gard. Herb.); Longemer, 2 July, 1881, *Study* (N. Y. Bot. Gard. Herb.); in bottom of Lakes Gerardmer, Longemer, and Retournemer, all the year (Stirp. Crypt. Vog.-Rhen., 1810-26), *Mougeot & Nestler 111* (N. Y. Bot. Gard. Herb.); lakes of the Vosges, 1833, *Mougeot* (N. Y. Bot. Gard. Herb.); in deep pools and ponds, through almost all the

year, *Desmazières 597* (N. Y. Bot. Gard. Herb.); lac de Guéry, near Mont Dore, Puy-de-Dôme, 14 September, 1879, *Heribaud* (N. Y. Bot. Gard. Herb.).

Spain: Lac de Bassibé, valley of the Rio Malo, Pyrenees Espagnoles, 11 August, 1880, *Lagrave* (N. Y. Bot. Gard. Herb.).

Norway and Sweden: lakes of Norway, *Blytt 1958* (Mo. Bot. Gard. Herb.); "N. Vi. s: N Vassviken vid Ribbingstrof," 11 August, 1870, (Ydre) *Dusen* (U. S. Nat. Herb.); "Vaerendia, Dref," August, 1879, *Hyltén-Cavallius 1771* (U. S. Nat. Herb.); "Augnil Hoysjs Mortsjord," July, 1887, *Franberg* (U. S. Nat. Herb.); Upland near Malaren, July, *Värnberg* (Mo. Bot. Gard. Herb. and Gray Herb.); "in Suecica", *Areschoug* (Gray Herb.); Uplandic, *Anderssen* (Mo. Bot. Gard. Herb.); "Smolandia Moheda," August, 1875, *Hyltén-Cavallius* (N. Y. Bot. Gard. Herb.); "Vedvson", July, 1868, *ex herb. Per Larson* (N. Y. Bot. Gard. Herb.); Smol. Moheda, lake, sand, August, 1881, *Hyltén-Cavallius* (N. Y. Bot. Gard. Herb.); near Stockholm, 1842, *Wicketson* (N. Y. Bot. Gard. Herb.).

Denmark: Madum Sö, 13 August, 1889, *Bergesen* (Mo. Bot. Gard. Herb.); Jutland, *Le Roy* (N. Y. Bot. Gard. Herb.); Landsee bei Espenkrug, *Klinsmann* (Mo. Bot. Gard. Herb.).

Germany: Grosser Teich (east side), Riesengebirge, August, 1866, *Engler* (N. Y. Bot. Gard. Herb.); Riesengebirge, August, 1866, *Ascherson* (Mo. Bot. Gard. Herb.); Titisee, Baden, August, 1846, *Braun* (Mo. Bot. Gard. Herb.); Titisee, May, 1846, *Braun* (Mo. Bot. Gard. Herb.); Titisee, July, 1864, *Braun* (Mo. Bot. Gard. Herb. and Gray Herb.); near Bütow, e. Pomerania, 1862, *Braun* (Mo. Bot. Gard. Herb.); near Heringsdorf, I. of Usedom, September, 1863, *Braun* (Mo. Bot. Gard. Herb.); in Lake Wjelling, near Bütow, 1867, *Doms* (Gray Herb.); Bütow, in Wjelling See, Pomerania, August, 1866, *Doms* (Mo. Bot. Gard. Herb.); Heringsdorf, Usedom, August, *Marrson 14* (Mo. Bot. Gard. Herb.); in Grosser Krebssee, near Heringsdorf, Usedom, September, 1864, *Braun* (Gray Herb.); Kleiner Krebssee, near Sallentin, I. of Usedom, September, 1864, *Braun* (Gray Herb., U. S. Nat. Herb., and N. Y. Bot. Gard. Herb.); Heringsdorf, in Kleiner Krebssee, 9 August, 1896, *Retter* (U. S. Nat. Herb.); Grosser

Krebssee, near Heringsdorf, I. of Usedom, 9 September, 1902, *without collector* (U. S. Nat. Herb.); "Feldsee bei Freiburg," 7 July, 1864, *Reess* (U. S. Nat. Herb.); Titisee near Freiburg, 1866, *Magnus* (U. S. Nat. Herb.); Titisee, Schwarzwald, 187-, *Reinsch* (U. S. Nat. Herb.); Feldbergsee, Schwarzwald, 30 June, 1868, *Zickendrath* (N. Y. Bot. Gard. Herb.); on stony bottom of Feldsee, Feldberg, Schwarzwald, 17 July, 1834, *Meisner* (N. Y. Bot. Gard. Herb.); Einfelder See, Lauenburg, Schleswig-Holstein, *Nolte 1601* (N. Y. Bot. Gard. Herb.); Titisee, 1000 m., September, 1885, *Christ* (N. Y. Bot. Gard. Herb.); 20–50 cm. below water surface, stony substratum, in Steinsee near Kirchseeon, upper Bavaria, July, 1900-01, and July & August, 1902, *Hepp 599* (Gray Herb.); in lake, Gardsee, Ratzeburg, September, 1864, *Reinke* (Gray Herb.); Grosser Teich, Riesengebirge, Silesia, July, 1866, *Milde* (Gray Herb.); Grosser Teich, Riesengebirge, 31 July, 1874, *Buchenau* (Gray Herb.); Wiggoda in Moritzsee, West Prussia, 10 May, 1885, *Lützow* (Gray Herb.); Gr. Ottalsiner See, West Prussia, 10 August, 1885, *Lützow* (Gray Herb.); Schluchsee in Black Forest, September, 1867, *without collector* (Gray Herb.); Riesengebirge, 24 August, 1884, *Hieronymus* (Mo. Bot. Gard. Herb.); near Danzig, W. Prussia, 1854, *Klebsman* (Mo. Bot. Gard. Herb.); millpond, "Lohmülle", near Lockstedter Lager, Holstein, August, 1886, *without collector* (Mo. Bot. Gard. Herb.).

Bohemia: Bistritzer See, near Eisenstein, *Celakovsky 1503* (U. S. Nat. Herb. and Gray Herb.).

Austria: "Grosser Teich," Sudetic Mts., *Milde* (Mo. Bot. Gard. Herb.).

Finland: Northern Lavonia, Kvopio, 26 July, 1901, *Budden* (U. S. Nat. Herb.); region of Abo "par. Lojo" in lacu Hormasjo, 6 September, 1893, *Boldt 17* (Mo. Bot. Gard. Herb.); same station, 27 August, 1909, *Boldt 418* (Mo. Bot. Gard. Herb.).

Russia: St. Petersburg, "Hellgründiger See in Lewaschweo," 2–19 August, 1898, *Poring* (U. S. Nat. Herb.).

52. I. occidentalis Hend. Bull. Torr. Bot. Club 27: 358. 1900.

I. lacustris var. *paupercula* Engelm. Trans. St. Louis Acad. Sci. 4: 377. 1882.

I. paupercula (Engelm.) Eaton. Proc. U. S. Nat. Mus. **23**: 649. 1901, and in Gilbert, List N. Am. Pterid. **10**: 28. 1901.

Corm 2-lobed; leaves commonly 9–30, rarely 60, 5–20 cm. long, dark green, rigid, gradually tapering, with wide membranaceous border at base, extending 2–3 times length of sporangium above level of latter; peripheral strands and stomata lacking; ligule short-triangular; sporangia almost orbicular, 5–6 mm. long, with narrow velum (covering about 1/3 of sporangium); megaspores cream-colored, 525–640 μ in diameter, marked with low conspicuous irregular crests, chiefly simple on the apical faces, branching to form irregular network on basal face; microspores 24–42 μ long, spinulose.

Distribution: Idaho, Wyoming, Colorado, California.

Specimens examined:

Idaho: in water from 6 in. to 6 ft. deep, Lake Coeur d'Alene, 22 August, 1897, *Henderson 2979* (Mo. Bot. Gard. Herb.); in 2 ft. of water, Lake Coeur d'Alene, August, 1898, *Henderson* (Mo. Bot. Gard. Herb.); in 2 ft. of water, Lake Coeur d'Alene, August-September, 1897, *Henderson 4786* (Gray Herb.).

Wyoming: Yellowstone Park, 1885, *Tweedy 416* (U. S. Nat. Herb. and Gray Herb.); growing in deep water at north end of Yellowstone Lake, 16 August, 1900, *Bessey 1* (N. Y. Bot. Gard. Herb.).

Colorado: "covering the bottom of Grand Lake in granitic sand, 3–4 ft. under the surface of water, abundant, meadow-like, Middle Park," 5 August, 1881, *Engelmann* (Mo. Bot. Gard. Herb.).

California: Donner Lake, September, 1887, *Curran* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); Donner Lake, *Shockley* (Mo. Bot. Gard. Herb.); Castle Lake, mountains about the headwaters of the Sacramento River, alt. 6000 ft., 14 August, 1881, *Pringle* (Mo. Bot. Gard. Herb. and Gray Herb.).

53. I. Piperi Eaton, Fern Bull. **13**: 51. 1905; name only in Fern Bull. **11**: 85. 1903; Piper, Contr. U. S. Nat. Herb. **11**: 89. 1906.

I. occidentalis var. *Piperi* (Eaton) Nelson & MacBride, Bot. Gaz. **61**: 30. 1916.

Corm 2-lobed; leaves 8–26, 3–10 cm., rarely 15 cm., long, medium fine, erect or somewhat spreading, taper-pointed, broadly winged for twice length of sporangium; peripheral strands and stomata lacking; ligule short, triangular, ovate; sporangia 4–5 mm. long, with variation in width of velum from 1/3 to 2/3 of sporangium; megaspores white, 540–800 μ in diameter, marked with points or tubercles and short ridges, sometimes slightly serpentine; microspores 29–35 μ, rarely 42 μ, long, papillose.

Distribution: Washington.

Specimens examined:

Washington: Seattle, 11 July, 1889, *Piper* (Mo. Bot. Gard. Herb.); Seattle, 11 July, 1889, *Smith* (Mo. Bot. Gard. Herb.); Lake Washington, near Seattle, 11 July, 1889, *Piper & Smith 651* (N. Y. Bot. Gard. Herb.); Green Lake, King Co., 12 July, 1895, *Piper 2317* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.), TYPE; mostly submerged in clear lake, Five Mile Lake, Tacoma, 3 October, 1902, *Flett 2034* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and N. Y. Bot. Gard. Herb.); Lake Washington, Seattle, August, 1907, *Piper & Hungate* (U. S. Nat. Herb.); submerged, Lake Crescent, 20 August, 1911, *Webster* (U. S. Nat. Herb.); in Green Lake, near Seattle, June, 1891, *Piper 1102* (N. Y. Bot. Gard. Herb.).

It is possible that *I. Piperi* Eaton and *I. occidentalis* Hend. may be more closely related than as adjacent species. A slight difference in habit of the leaves (more gradual tapering in *I. occidentalis,* coupled with greater length), a difference in spore sizes, with *I. Piperi* tending to show the larger megaspores and smaller microspores, and a simpler form of sculpture on *I. Piperi* compared with the anastomosing ridges of *I. occidentalis,* and a tendency toward wider velum in *I. Piperi,* serve to distinguish these two submerged species.

SECT. 4. RETICULATAE

§ 4. RETICULATAE. Forms with 2-3 lobed corms; producing megaspores evidently reticulate, at least on basal face; microspores smooth or rough.

Key to Species

A. Corms 2-lobed.
  a. Submersed forms, stomata none or rare.
    α. Megaspores chiefly 600–800 μ in diameter.
      I. Spore markings irregular, sharp crests ..... *54. I. macrospora*
      II. Spore markings prominent, rounded ridges ..... *54a. I. macrospora* f. *hieroglyphica*
    β. Megaspores chiefly 460–600 μ in diameter ..... *55. I. Tuckermani*
  b. Amphibious forms, stomata at least near leaf tips.
    α. Leaves less than 18 cm. long ..... *56. I. foveolata*
    β. Leaves chiefly more than 18 cm. long.
      I. Megaspores large, over 580 μ in diameter ..... *57. I. Martii*
      II. Megaspores usually less than 580 μ in diameter.
        1. Spore surface reticulate with narrow ridges, 400–570 μ in diameter.
          *Velum narrow, covering less than ⅓ of sporangium ..... *58. I. Engelmanni*
          **Velum covering ⅓–⅔ of sporangium ..... *58a. I. Engelmanni* var. *caroliniana*
        2. Spore surface reticulate with rounded ridges, 360–490 μ in diameter ..... *59. I. azorica*
B. Corms 3-lobed.
  a. Aquatic, lacking velum.
    α. Peripheral strands present ..... *60. I. japonica*
    β Peripheral strands lacking ..... *61. I. Wormaldii*
  b. Terrestrial, with complete velum ..... *62. I. Duriaei*

54. I. macrospora Dur. Bull. Soc. Bot. Fr. **11**: 101. 1864; Clute, Fern Allies, 224. 1905; Eaton in Gray, Manual, ed. 7, 58. 1908; Maxon in Britton & Brown, Ill. Fl., ed. 2, **1**: 50. 1913.

I. lacustris Engelm. Trans. St. Louis Acad. Sci. **4**: 377. 1882; Motel. & Vendr. Actes Soc. Linn. Bord. **36**: 325. 1883; Baker, Jour. Bot. **18**: 67. 1880.

I. Harveyi Eaton, Fernwort Papers, 11. 1900.

I. Tuckermani var. *Harveyi* Clute, Fern Allies, 226. 1905.

I. heterospora Eaton, Fernwort Papers, 8. 1900.

I. macrospora var. *heterospora* Eaton, Rhodora **10**: 42. 1908.

I. Tuckermani heterospora Clute, Fern Allies, 227, 260. 1905.

Corm 2-lobed; leaves usually 13–40, occasionally more numerous, 5–22 cm. in length, rigid, slightly to decidedly coarse, abruptly tapering to apex; peripheral strands lacking; stomata absent or very rare; ligule short triangular; sporangia 3–5 mm. long, with narrow velum; megaspores white, 600 (550)–800 μ, or more in rare cases, with sculpture of irregular ridges more or less parallel, with little confluence on upper faces, anastomosing, sometimes with clear reticulations on the lower face; microspores 33–45 (50) μ long, short spinulose.

Distribution: Newfoundland west to Minnesota.

Specimens examined:

Newfoundland: in shallow water of sandy pond, Torbay, 1901, *Howe & Lang 1424* (N. Y. Bot. Gard. Herb. and Gray Herb.); Whitbourne, 8 August, 1911, *Fernald & Wiegand 4409* (Gray Herb.).

Quebec: in 2–6 dm. water, rooting in close-packed granite gravel, Lac des Americains, alt. 675 m., western base of Table-Top, Mt. Gaspé, 1–2 August, 1906, *Fernald & Collins 155* (Mo. Bot. Gard. Herb., Gray Herb., and Univ. Minn. Herb.); alpine lakes, alt. 900–1000 m., Lac Fortin, Table-Top, Mt. Gaspé Co., 10 August, 1906, *Fernald & Collins 319* (Gray Herb.); Lac 43, Mt. Gaspé Co., 4 August, 1906, *Fernald & Collins 317* (Gray Herb.).

Nova Scotia: in shallow water, sandy soil, lake, North Sydney, Cape Breton, 1901, *Howe & Lang 763* (N. Y. Bot. Gard. Herb.); Warren Lake, Cape Breton Isl., 15 August, 1914, *Nichols 877* (Gray Herb.); cobbly margins of east branch of Tusket River, Gavelton, Yarmouth Co., 4 September, 1920, *Fernald, Long & Linder 19625* (Mo. Bot. Gard. Herb).

Maine: brook flowing into north end of Jordan's Pond, Mt. Desert I., 22 July, 1889, *Redfield 2726* (Mo. Bot. Gard. Herb.); under water, Somes Stream, Mt. Desert I., 27 July, 1892, *Rand* (Mo. Bot. Gard. Herb.); Deer Brook Beach, Jordan Pond, 23 August, 1892, *Rand* (Mo. Bot. Gard. Herb.); south shore of Jordan Pond, 10 September, 1894, *Rand 3* (Mo. Bot. Gard. Herb.); in shallow water where a cold spring enters the pond, Northwest Pond, north Franklin Co., 14 July, 1895, *Coville 83* (N. Y. Bot. Gard. Herb. and U. S. Nat. Herb.); in 2 ft. water, gravelly bottom, Kennebago Lake, 5 mi. north of Rangeley, 12 July, 1895, *Coville 78* (N. Y. Bot. Gard. Herb. and U. S. Nat. Herb.); Penobscot River, Orono, September, 1895, *F. L. Harvey 1* (N. Y. Bot. Gard. Herb.); Bubble Pond, Mt. Desert I., 11 September, 1895, *Rand 2* (Mo. Bot. Gard. Herb.); Pushaw Pond, Oldtown, August, 1895, *Harvey 2* (N. Y. Bot. Gard. Herb.); Pushaw Pond, 21 August, 1899, *F. L. Harvey* (U. S. Nat. Herb. and Mo. Bot. Gard. Herb.); Pushaw Pond, Oldtown, 21 August, 1899, *L. H. Harvey 1411* (U. S. Nat. Herb.); rocky shore, "Lake Cowles," Mt. Ktaadn, 15–30 August, 1902, *Cowles & Harvey*

1 (Mo. Bot. Gard. Herb.); Lower Basin Pond, Mt. Ktaadn, 15–30 August, 1902, *Harvey 3* (Mo. Bot. Gard. Herb.); growing in 18 in. water at unusually low stage of water, Pushaw Pond, Orono, 17 September, 1905, *Knight 14* (Mo. Bot. Gard. Herb. and Gray Herb.).

New Hampshire: Echo Lake, Franconia Mt., 17 September, 1856, *Engelmann* (Mo. Bot. Gard. Herb.).

Vermont: near old mill, east shore and Long Cove, Willoughby Lake, 3, 5, 7 August, 1907, *Winslow* (Mo. Bot. Gard. Herb.); Willoughby, 2 September, 1900, *Lovery* (Gray Herb.); shore of Silver Lake, Leicester, 10 July, 1910, *Dutton 787* (Mo. Bot. Gard. Herb.).

Massachusetts: Fresh Pond, north side, 20 August, 1867, *Boott 11* (Mo. Bot. Gard. Herb.); same station and date, without number (Gray Herb.); same station, 12 August, 1868, *Boott* (N. Y. Bot. Gard. Herb.); Uxbridge, without date, *Robbins 1* (N. Y. Bot. Gard. Herb.).

New York: Catskill Mts., *Schweinitz* (Mo. Bot. Gard. Herb.), probably TYPE; Third Lake, Fulton Chain, September, 1899, *Underwood* (N. Y. Bot. Gard. Herb.); Clear Lake, south of Elk Lake, Adirondacks, 4 September, 1894, *Britton* (N. Y. Bot. Gard. Herb.).

Michigan: small lake near Douglas Lake, Cheboygan Co., August, 1918, *Praeger* (Mo. Bot. Gard. Herb.); Isle Royale, 6 August, 1901, *Cooper 26* (Gray Herb.); in 1–2 ft. water, Vincent Lake, Cheboygan Co., 15 August, 1917, *Ehlers 621* (Gray Herb.); Vincent Lake, 30 July, 1918, *Ehlers 817* (Mo. Bot. Gard. Herb.).

Minnesota: Devils Track Lake, Cook Co., 28 August, 1901, *Lyon* (Mo. Bot. Gard. Herb.).

54a. Forma hieroglyphica Pfeiffer, comb. nov.

I. hieroglyphica Eaton, Fernwort Papers, 10. 1900.

Habit of the species; megaspores 560–720 μ in diameter, rarely less, marked with prominent rounded or smooth ridges, slightly reticulate on upper faces, decidedly so on lower, sometimes naked near commissural ridges; microspores as in species.

Specimens examined:

Maine: St. Francis Lakes between Maine and Canada, 31 July, 1889, *Pringle* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., Gray

Herb., and N. Y. Bot. Gard. Herb.), TYPE; in 4 ft. of water off the dock, Maneskootuk, Rangeley Lake, 7 July, 1895, *Coville 62* (U. S. Nat. Herb. and N. Y. Bot. Gard. Herb.); Moosehead Lake, September, 1899, *F. L. Harvey 4* (Mo. Bot. Gard. Herb.).

55. **I. Tuckermani** A. Br. acc. Engelm. in Gray, Manual, ed. 5, 676. 1867; Engelm. Trans. St. Louis Acad. Sci. 4: 378. 1882; Motel. & Vendr. Actes Linn. Soc. Bord. 36: 338. 1883; Baker, Jour. Bot. 18: 68. 1880, and Fern Allies, 126. 1887; Underwood, Native Ferns and Fern Allies, 122. 1882; Macoun, Cat. Canad. Pl. pt. 4: 293. 1888; Eaton in Gray, Manual, ed. 7, 59. 1908; Britton & Brown, Ill. Fl., ed. 2, 1: 51. 1913; Clute, Fern Allies, 225. 1905.

I. Tuckermani var. *borealis* Eaton, Fernwort Papers, 10. 1900.

Calamaria Tuckermani Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed, rarely 3; leaves 5–38, 3–18 cm. long, very slender, tapering, olive-green, outer leaves frequently recurved; stomata lacking or few in number; peripheral strands none; sporangia orbicular to oblong, 2–5 mm. long, often brown-spotted; velum incomplete, covering about 1/3 of sporangium; megaspores white, 460–600 μ, rarely 650 μ, in diameter, with upper segments marked with somewhat parallel and branching thin ridges, chiefly irregular at margins, lower segment with reticulate ridges; microspores 26–34 μ, rarely more (40) in length, smooth to minutely papillose.

Distribution: Labrador, Newfoundland, Quebec, Nova Scotia, Maine, New Hampshire, Vermont, Massachusetts, Connecticut.

Specimens examined:

Labrador: pond, Triangular Harbor, 23 August, 1882, *Allen* (Mo. Bot. Gard. Herb.).

Newfoundland: in 3–6 in. water, Quiddy Viddy Lake, *Robinson & Schrenk 239* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., N. Y. Bot. Gard. Herb., Univ. Minn. Herb., and Gray Herb.).

Quebec: on firm clay bottom, small ponds among Silurian hills back of Birchy Cove (Curling), 11 August, 1910, *Fernald & Wiegand 2404* (Gray Herb.); emersed, muddy border of a shallow brook, Lewisport, south shores of Notre Dame Bay, 17 August, 1911, *Fernald & Wiegand 4402* (Gray Herb.).

Nova Scotia: in Pleasant Lake, Springfield, 16 August, 1910, *Macoun 81092* (Gray Herb.); pond, North Sydney, Cape Breton Isl., 14 July, 1883, *Macoun 14223* (in part) (Gray Herb. and N. Y. Bot. Gard. Herb.); Boylston, August, 1890, *Hamilton 81051* (in part) (Gray Herb.); in a brook, Bridgewater, 28 July, 1910, *J. Macoun 81091* (Gray Herb.); shallow water of Midway (Centreville) Lake, Centreville, Digby Co., 22 August, 1920, *Graves & Linder 19621* (Mo. Bot. Gard. Herb.); quiet pools in Little River and pond holes in savannahs east of Tidville, Digby Co., 22 August, 1920, *Fernald & Long 19620* (Mo. Bot. Gard. Herb.); shallow water at sandy margin of Great Pubnico Lake, Yarmouth Co., 6 September, 1920, *Fernald, Long & Linder 19627* (Mo. Bot. Gard. Herb.); peaty margin of Kegeshook Lake, Yarmouth Co., 8 October, 1920, *Fernald & Linder 19630* (Mo. Bot. Gard. Herb.); peaty and muddy, dried-out pond-hole near the head of St. John Lake, Springhaven, Yarmouth Co., 8 October, 1920, *Fernald & Linder 19631* (Mo. Bot. Gard. Herb.); shallow water of Everitt Lake, 10 August, 1921, *Fernald & Long 23109* (Mo. Bot. Gard. Herb.).

Maine: Mt. Desert, 23 July, 1871, *Boott* (N. Y. Bot. Gard. Herb.); Mt. Desert I., Somes Stream, 4 Sept., 1895, *E. & C. E. Faxon* (Gray Herb.); Pushaw Pond, 21 August, 1899, *F. L. Harvey 3* (Mo. Bot. Gard. Herb.); Ripples Brook, under water, Somesville, 1 August, 1892, *Rand* (Gray Herb.); brook, north end of Dunning's Pond, Somesville, 27 August, 1869, *Boott* (N. Y. Bot. Gard. Herb.); Ripple Brook, Somesville, Mt. Desert I., 1 August, 1892, 3 October, 1893, *Rand* (Mo. Bot. Gard. Herb.); Somes Stream, Mt. Desert I., 30 September, 1893, *Rand* (N. Y. Bot. Gard. Herb.); same station, 4 September, 1895, *Rand* (Mo. Bot. Gard. Herb.); west shore of Jordan's Pond, Mt. Desert I., 3 September, 1892, *Rand* (Mo. Bot. Gard. Herb.); Small Pond, north of Long Pond and Ripples Brook, and north end of Great Pond, "Northwest Arm," 22 September, 1892, *Fernald* (Gray Herb.); brook, south end of Ripple Pond, Mt. Desert I., 3 October, 1893, *Rand* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); at dam, Ripples Pond, in gravel mud, Mt. Desert I., 19 September, 1898, *Rand* (Mo. Bot. Gard. Herb. and Gray Herb.); in brook, inlet of Ripples Pond,

19 September, 1898, *Rand* (Gray Herb.); in clay mud, south end Great Pond, Mt. Desert I., 19 September, 1898, *Rand* (Mo. Bot. Gard. Herb.); west shore of Jordan Pond, Mt. Desert I., in sand under water, 3 September, 1892, *Rand* (Mo. Bot. Gard. Herb.); pond north of Long Pond, Mt. Desert I., 22 September, 1892, *Fernald* (Gray Herb.); Ripples Pond, 22 September, 1892, *Fernald* (N. Y. Bot. Gard. Herb.); rocky bed of Great Works River, North Berwick, York Co., 25 September, 1897, *Fernald* (Gray Herb.); Bubble Pond, Mt. Desert I., 11 September, 1895, *Rand* (Mo. Bot. Gard. Herb.); same, 18 September, 1898, *Rand* (Mo. Bot. Gard. Herb.); ledgy margin of Stillwater River, Orono, 4 September, 1893, *Fernald y* (Gray Herb. and N. Y. Bot. Gard. Herb.); submersed, at end Eagle Lake, Mt. Desert I., 20 September, 1900, *Rand* (Gray Herb.); Harrison, Cumberland Co., 31 July, 1919, *Eames & Godfrey 9604* (Gray Herb.); York, August, 1893, *Thaxter* (Gray Herb.); gravelly margin of Pease River, East Wilton, 11 August, 1894, *Fernald* (Gray Herb.); mill stream, Somesville, 10 July, 1893, *Rand & Redfield 3121* (Mo. Bot. Gard. Herb.).

New Hampshire: Echo Lake, N. Conway, 8 June, 1879, *Faxon* (Mo. Bot. Gard. Herb. and Gray Herb.); sandy bottom of ponds, Kingston, August, 1895, *Eaton* (N. Y. Bot. Gard. Herb.); country pond, Newton, 18 August, 1896, *Eaton 440* (Mo. Bot. Gard. Herb.); millpond, Lamprey R., West Epping, 20 August, 1896, *Eaton* (U. S. Nat. Herb. and Univ. Minn. Herb.); country pond, Kingston, 5 August, 1896, *Dodge* (N. Y. Bot. Gard. Herb.); bed of Lamprey R., Epping, 16 September, 1896, *Eaton* (Mo. Bot. Gard. Herb.); West Epping, 20 August, 1896, *Eaton 482C* (Mo. Bot. Gard. Herb.); Gustin Pond, Marlow, 29 July, 1899, *Fernald 186* (in part) (Gray Herb.); Pautuckaway Pond, Nottingham, *Eaton 483B* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); same locality, 20 August, 1896, *Eaton* (Univ. Minn. Herb.); Epping, 12 August, 1896, *Eaton 424, 431* (Mo. Bot. Gard. Herb.); Epping Corner, *Eaton* (Mo. Bot. Gard. Herb.); Gould Pond, Greenfield, in about 3 ft. water, among yellow lilies, mud over granite gravel, 24 July, 1906, *Coville 2219* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); country pond, Kingston,

September, 1895, *Eaton* (Univ. Minn. Herb.); Lake Chocorua, 10 September, 1906, *Farlow* (Gray Herb.); Lamprey River at Hedding, in about 10 in. water, 8 August, 1904, *Bragg* (N. Y. Bot. Gard. Herb.).

Vermont: Grout Pond, Stratton, alt. 2225 ft., 6–10 August, 1900, *Eggleston 2200* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.); South Pond, Marlboro, 15 September, 1895, *Grout & Eggleston* (N. Y. Bot. Gard. Herb.); sandy shore of Kelly's Bay, Alburgh, 31 August, 1893, *Eggleston* (N. Y. Bot. Gard. Herb.); Lamprey R., Epping, 16 September, 1899, *Eaton* (Univ. Minn. Herb.).

Massachusetts: in the Mystic, not the Pond, Medford, August, 1848, *Tuckerman* (Gray Herb.), TYPE; submersed at margin of winter pond, Winchester, 22 September, 1908, *Fernald* (Gray Herb.); Arlington, 15 September, 1867, *Boott* (Gray Herb.); Martin's Pond, Reading, 24 August, 1869, *Boott* (N. Y. Bot. Gard. Herb.); Pinkapog Pond, 27 August, 1867, *Boott* (N. Y. Bot. Gard. Herb.); submerged, Worcester, *Stone* (N. Y. Bot. Gard. Herb.); Horn Pond, south end, 16 September, 1869, *Boott* (N. Y. Bot. Gard. Herb.); Kimball's Pond, Amesbury, 15 August, 1899, *Eaton* (Univ. Minn. Herb.); Mystic Pond, 6 August, 1865, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Mystic River near Boston, from issue from Mystic Pond to Wood's Dam, 21 October, 1866, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); east side of Mystic Pond, 14 July, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); north and west side of Mystic Pond, 9 August, 28 October, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); north and east sides of Spy Pond, Arlington, 5–8 September, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Fresh Pond, north side, 3 September, 1868, *Boott* (Gray Herb.); entirely submerged, Spy Pond, Arlington, August, 1878, *Morong* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and U. S. Nat. Herb.); Nutting Pond, Billerica, 11 August, 1869, *Boott* (N. Y. Bot. Gard. Herb.); entirely submerged, Horn Pond, 29 October, 1866, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Spy Pond, Arlington, 8 August, 1881, *Morong* (N. Y. Bot. Gard. Herb.); lower end of Horn Pond, 30 June, 1867, *Boott*

(Gray Herb.); Horn Pond, 11 July, 16 September, 1867, *Boott* (Mo. Bot. Gard. Herb. and Gray Herb.); Waushakum Pond, So. Framingham, 29 June, 20 July, 1890, *Sturtevant* (Mo. Bot. Gard. Herb.); sandy bottom, Lake Attitash, Amesbury, August, September, 1895, *Eaton* (Mo. Bot. Gard. Herb., U. S. Nat. Herb., and Univ. Minn. Herb.); Quannaponit Lake, Wakefield, 10 September, 1869, *Boott* (N. Y. Bot. Gard. Herb.); Attitash, Essex Co., *Eaton 960* (Mo. Bot. Gard. Herb.); same, 27 June, 1896, *Eaton 197* (Mo. Bot. Gard. Herb.); same, 31 July, 1896, *Eaton 382* (Mo. Bot. Gard. Herb.); Chebacco Pond, Essex Co., 15 July, 1896, *Dodge* (N. Y. Bot. Gard. Herb.); Chebacco Lake, Essex Co., August, 1896, *Eaton* (Mo. Bot. Gard. Herb. and Univ. Minn. Herb.); same, without date, *Eaton 378* (Mo. Bot. Gard. Herb.); Chebacco Lake, Essex Co., 18 July, 1896, *Dodge* (Gray Herb.); Bate's Pond, Wenham, 29 July, 1896, *Eaton 376* (Mo. Bot. Gard. Herb.); Nine-Mile Pond, Cape Cod, 4 September, 1898, *Greenman 424* (Mo. Bot. Gard. Herb.); Watson's Pond, Taunton, 15 September, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Winneconnet Pond, Norton, 14 July, 1903, *Eaton* (Mo. Bot. Gard. Herb.); Merrimac River, Newburyport, August, 1896, *Dodge* (N. Y. Bot. Gard. Herb.); in fresh water, tidal shores Merrimac R., Newburyport, 1896, *Eaton* (Mo. Bot. Gard. Herb.); Kimball's Pond, Amesbury, July, 1896, and August, 1897, *Eaton* (Mo. Bot. Gard. Herb.); Kimball's Pond, Amesbury, 27 June, 1896, *Eaton* (Univ. Minn. Herb.); Kimball's Pond, Essex Co., 13 August, 1899, *Eaton* (Mo. Bot. Gard. Herb.); near Jerry's Pond, West Tisbury, Martha's Vineyard, 24 August, 1916, *Seymour 1017* (Gray Herb.); Lake Cochichewick, North Andover, 24 September, 1903, *Pease 2640* (Gray Herb.); submerged in shallow water, sandy margin of Great Pond, Weymouth, Norfolk Co., 2 September, 1918, *Churchill* (Mo. Bot. Gard. Herb.); carpeting the sandy bottom of Spectacle Pond, Wellfleet, Barnstable Co., 19 September, 1918, *Fernald & Weatherby 15950* (Gray Herb. and Mo. Bot. Gard. Herb.); sandy bottom, Great Pond, Weymouth, 2 September, 1918, *Knowlton* (Mo. Bot. Gard. Herb. and Gray Herb.); Buck Pond, Harwich, wet sandy lower beach and inundated margin, 30 August,

1918, *Fernald & Long 15949* (Gray Herb. and Mo. Bot. Gard. Herb.).

Connecticut: muddy border of pond, Niantic, East Lyme, 19 August, 1913, *Bissell* (Gray Herb.); submerged, stony shore, lower end of Long Pond, Ledyard, 4 August, 1896, *Graves 139 & 140* (Mo. Bot. Gard. Herb.); same place and date, *Graves* (Gray Herb.); in mud, bare at low water, head of Hamburg Cove, Lyme, 10 September, 1902, *Graves* (Mo. Bot. Gard. Herb.).

56. **I. foveolata** A.A. Eaton in Dodge, Ferns and Fern Allies of N. Eng. 38. 1896.

Corm 2-lobed, rarely 3; leaves 20–45, 8–18 cm. long, rather slender, round, becoming dark green; stomata few, near tips of leaves; peripheral strands none; ligule short triangular; sporangia 4–7 mm. long, brown-spotted, with very narrow velum; megaspores white, 360–560 μ, rarely 600 μ, in diameter, densely sculptured with somewhat irregular reticulations formed by wide, high ridges surrounding deep pits; microspores 23–33 μ long, minutely papillose.

Distribution: New Hampshire.

Specimens examined:

New Hampshire: pond on Lamprey River, Epping, 20 August, 1896, *Eaton* (Mo. Bot. Gard. Herb. and Gray Herb.), TYPE; West Epping, 20 August, 1896, *Eaton 482A* (Mo. Bot. Gard. Herb. and Gray Herb.); Epping Corner, 14 September, 1899, *Eaton 299* (Mo. Bot. Gard. Herb.); New Market, *Eaton* (Mo. Bot. Gard. Herb.); Epping, Pautuckaway River, *Eaton 432* (Mo. Bot. Gard. Herb.); Lamprey River, Epping, August, 1897, *Eaton* (Mo. Bot. Gard. Herb.).

57. **I. Martii** A. Br. Kuhn in Martius, Fl. Brasil. 1^2: 646. *pl. 78.* 1884; Baker, Fern Allies, 129. 1887.

Corm 2-lobed, small; leaves 24–52, up to 75 cm. in length, soft green, flexuous, reddish brown at base, with membranaceous margins extending 6–8 cm. above sporangium level; stomata near tips of leaves, lacking below; peripheral strands usually lacking or weak; ligule cordate-triangular; sporangium 6–8 mm. long, partly covered by velum (1/2–2/3); megaspores chalky white, 580–660 μ in diameter, marked with irregular, confluent,

high, blade-like ridges, extending away from commissural ridges on upper faces, somewhat incompletely reticulate above, irregularly reticulate basally; microspores fawn-colored, 30–35 μ long, smooth.

Distribution: Brazil.

Specimens examined:

Brazil: Prov. Minas Geraës, 22 January, 1874, 18 December, 1864, *Regnell ser. III 1506* (Gray Herb. and U. S. Nat. Herb.), TYPE; Serra do Itatiaia, " in rivulo," 29 June, 1902, *Dusen 643* (U. S. Nat. Herb.).

58. **I. Engelmanni** A. Br. Flora **29**. 178. 1846; Baker, Jour. Bot. **18**: 105. 1880; Motel. & Vendr. Actes Linn. Soc. Bord. **36**: 374. *pl. 12. fig. 1–9.* 1883; Gray, Manual, ed. 4, 606. 1869; Clute, Fern Allies, 233. 1905.

I. Engelmanni var. *gracilis* Engelm. in Gray, Manual, ed. 5, 677. 1867.

I. Engelmanni var. *fontana* Eaton, Fern Bull. **13**: 52. 1905.

I. Engelmanni var. *valida* Engelm. in Gray, Manual, ed. 5, 677. 1867.

I. valida Clute, Fern Allies, 236, 260. 1905.

Corm 2-lobed; leaves 15–60 (100), 13–50 cm. long, light green; stomata numerous; peripheral strands variable in number or none; sporangia oblong, unspotted, with narrow velum; megaspores white, 400–570 (615) μ in diameter, distinctly marked with honeycomb network of narrow ridges; microspores 21–30 μ, seldom 33 μ, in length, smooth to minutely roughened.

Distribution: eastern border to Mississippi Valley.

Specimens examined:

New Hampshire: "In a slight brooklet, dry most of the summer," in a forest, Seabrook, July, 1895, *Eaton* (Mo. Bot. Gard. Herb.); millpond, in clay, Hampton Falls, August, 1895, *Eaton* (Mo. Bot. Gard. Herb.); Coffin's Mill, 16 July, 1896, *Eaton* (Mo. Bot. Gard. Herb.); mill-pond, Hampton Falls, 1 August, 1896, *Eaton* (Mo. Bot. Gard. Herb.); Powow River, South Hampton, 18 August, 1896, *Eaton 439* (Mo. Bot. Gard. Herb.); Trickling Falls, 1896, *Eaton* (Mo. Bot. Gard. Herb.); East Kingston, 28 July, 1896, *Eaton 363–364* (Mo. Bot. Gard. Herb.); flats at East Kingston, 6 July, 1896, *Eaton 231* (Mo.

Bot. Gard. Herb.); flats at Trickling Falls, Kingston, August, 1897, *Eaton* (Mo. Bot. Gard. Herb.); Dodge's Pond, Hampton Falls, *Eaton* (Mo. Bot. Gard. Herb.); Horse Hill, Kensington, 19 April, 1896, *Eaton 1* (Mo. Bot. Gard. Herb.); Lamprey River, Epping, August, 1897, *Eaton* (Mo. Bot. Gard. Herb.); Stratham, 1899, *Eaton* (Mo. Bot. Gard. Herb.).

Vermont: in Clark's Pond, near Brattleborough, " in spring submerged, in fall on dry banks," 1867, *Mann* (Mo. Bot. Gard. Herb.); Brattleborough, 1867, *Frost 18* (Gray Herb.); in shallow water on muddy bottom, Little Pond, Orwell, 8 August, 1915, *Eames & Godfrey 9204a* (Gray Herb.).

Massachusetts: Woburn Brook, 16 November, 1862, *Boott* (Mo. Bot. Gard. Herb.); millpond stream in West Cambridge, 26 October & 5 November, 1865, *Boott* (Mo. Bot. Gard. Herb.); West Cambridge, entirely out of water, 26 October, 1865, *Boott* (Gray Herb.); West Cambridge Brook, entirely submerged (5 miles northwest from Boston), 29 October, 1866, *Boott* (Mo. Bot. Gard. Herb.); Arlington Brook, 23 October, 1867, *Boott* (Mo. Bot. Gard. Herb.); Arlington Brook, 12 September, 1867, *Boott* (Mo. Bot. Gard. Herb.); Arlington Brook, 7 August, 1870, *Boott* (Gray Herb.); South Natick, 25 June, 1879, *Morong* (Mo. Bot. Gard. Herb. and Gray Herb.); in water and mud along margin where pond has dried away, Blacksmith Pond, Needham, 19 July, 1885, *Fuller* (Gray Herb.); near dam, Waverley, November, 1894, *Duggar* (Gray Herb.); mill-pond, Waverley, October, 1894, *Seymour* (Gray Herb.); Newburyport, 22 June, 1894, *Dodge* (Mo. Bot. Gard. Herb.); West Newbury, July, 1896, *Dodge* (Mo. Bot. Gard. Herb.); Tuxbury's Pond, *Eaton* (Mo. Bot. Gard. Herb.); Waverley, 11 October, 1894, *Blankinship* (Mo. Bot. Gard. Herb.); Blue Hills Reservation, Metropolitan Park System, 2 September, 1895, *Jenks* (Mo. Bot. Gard. Herb.); Pine Tree Pool, Blue Hills Reservation, 2 September, 1895, *Williams* (Gray Herb.); in brook, Blue Hills, Quincy, 5 September, 1895, *Fernald* (Gray Herb.); Shaker Glen, Woburn, 1 September, 1895, *Williams* (Gray Herb.); Race Course Pond, Billingham, 24 August, 1894, *E. & C. E. Faxon* (Gray Herb.); Nashawena Island, Buzzards Bay, *C. E. Faxon 7* (Mo. Bot. Gard. Herb. and Gray

Herb.); in shallow water, Blue Hills Reservation, West Quincy, 2 September, 1895, *Rich* (Gray Herb.); pool, heart of Pine-Tree Brook, Blue Hills Reservation, Milton, 2 September, 1895, *Churchill* (Gray Herb.).

Rhode Island: Newport, July, 1878, *C. E. Faxon 5* (Mo. Bot. Gard. Herb. and Gray Herb.); near Newport, in deep water, 1866, *Durand* (Mo. Bot. Gard. Herb.); shallow pool, Newport, 1878, *Farlow* (Mo. Bot. Gard. Herb,); (Wordens Pond) "Lake Werden," So. Kingston, 24 August, 1881, *E. & C. E. Faxon* (Gray Herb.); Newport, *Thurber* (Gray Herb.).

Connecticut: fresh water, tidal shores, New Haven, 1857, *D. C. Eaton 1* (Mo. Bot. Gard. Herb.); without date, New Haven, *D. C. Eaton* (Gray Herb.); shallow mountain stream on gravelly bottom, Colebrooks, 10 September, 1864, *Robbins 13* (Mo. Bot. Gard. Herb.); edge of little pond in Meriden, pond south of West Peak, 10 October, 1873, *Hall* (Mo. Bot. Gard. Herb.); Bristol, 1888, *Bishop* (U. S. Nat. Herb.); Hart's Upper Reservoir, Berlin, 27 September, 1900, *Bishop* (Gray Herb.); shallow water, Eight-Mile River "at railroad," Southington, 3 August, 1902, *Bissell* (Mo. Bot. Gard. Herb.); submerged in shallow water of Mill River, Easton, 29 August, 1897, *Eames* (Gray Herb.); shallow water of pond, in mud, Stafford, 28 August, 1903, *Bissell* (Mo. Bot. Gard. Herb.); pond at Stafford St., Stafford, 28 August, 1903, *Bissell* (Gray Herb.); Bantam Lake, July, 1891, *Underwood* (Gray Herb.); Rainbow Park, Windsor, 30 August, 1907, *Eaton* (Mo. Bot. Gard. Herb.); Selden's Cove, Lyme, 28 August, 1907, *Eaton* (Mo. Bot. Gard. Herb.); "Curtis' Mill-Pond," Stepney, 11 September, 1897, *Eames* (Gray Herb.); pond at icehouse, Norwalk, 16 September, 1901, *Bissell* (Gray Herb.); in shallow water, Waterbury, 7 July, 1908, *Blewitt* (Gray Herb.); New Britain, 22 June, 1913, *Lunt* (Gray Herb.); small pond at foot of West Peak, Meriden, 25 September, 1910, *Bissell* (Gray Herb.); wet bank of pond, Gaylordsville, 29 August, 1904, *Eames* (Gray Herb.); Miamus River, Stamford, 5 July, 1909, *Eames & Godfrey 8223* (Gray Herb.); abundant in Bunnell's Pond, in 1–3 ft. water, Bridgeport, 5 August, 1913, *Eames* (Gray Herb.); in half-shade, shallow water of pond, southeastern

part of town of Sterling, 12 August, 1914, *Bissell* (Gray Herb.).

New York: high water mark, muddy shores just above Peekskill, 19 August and 3 September, 1869, *Leggett?* (Gray Herb.); Peekskill, Hudson River, high water mark, 3 September, 1869, *Leggett* (Mo. Bot. Gard. Herb.); Locke Pond, Central New York, 21 July, 1881, *Dudley* (Mo. Bot. Gard. Herb.); marl ponds, South Cortland, 29 June, 1884, *Dudley* (Mo. Bot. Gard. Herb.); east side, Cayuta Lake, in sand, 21 June, 1885, *Dudley A* (Mo. Bot. Gard. Herb.); marl pond near South Cortland, 3 August, 1886, *Dudley* (Mo. Bot. Gard. Herb.); near Norwich, Chenango Co., 21 August, 1888, *Fitch* (Mo. Bot. Gard. Herb.); near Ithaca, 1898, *Overacker* (Mo. Bot. Gard. Herb.); Ithaca, July, 1898, *Ashe* (Mo. Bot. Gard. Herb.); Mt. Vernon, 28 October, 1900, *Clute* (Mo. Bot. Gard. Herb.); brook at East Chester, 28 October, 1900, *Buchheister* (Mo. Bot. Gard. Herb.); pond, McLean, 19 July, 1916, *Munz 479* (Pomona Coll. Herb.); muddy border of Isoetes Pond, South Cortland, 18 July, 1915, *Faull 3430* (Gray Herb.); in 3 ft. of water near south end of Lake Ronkonkoma, Suffolk Co., 5 July, 1908, *Harper 38* (Gray Herb.); mudhole southwest of Chicago bog, Cortland, 22 July, 1916, *McDaniels 5446* (Mo. Bot. Gard. Herb.); Sparta, 16 August, 1907, *von Schrenk* $\frac{250}{07}$ (Mo. Bot. Gard. Herb.); in dried pond, Chicago Station, Ithaca, 6 August, 1921, *Drushel 4664* (Mo. Bot. Gard. Herb.).

New Jersey: near Camden, opposite Philadelphia, September, 1863, *Durand* (Mo. Bot. Gard. Herb.); "mud and spring water", 5½ miles from Philadelphia in N. J., 1 October, 1865, *Smith* (Mo. Bot. Gard. Herb.); in a ditch on the Atlantic City Railroad, 4 miles from Camden, 1866, *Durand* (Mo. Bot. Gard. Herb.); pool 3½ miles from Camden, on railroad to Atlantic City, end of October, 1867, *Durand* (Mo. Bot. Gard. Herb.); Closter, 1859, *Austin 3* (Mo. Bot. Gard. Herb.); bottom of Hackensack River, without date, *Austin* (U. S. Nat. Herb.); submerged, sandy bottom, Panther Pond, Sussex Co., 18 September, 1904, *Mackenzie 1059* (Mo. Bot. Gard. Herb.).

Pennsylvania: West Chester, 1839, *McMinn* (U. S. Nat. Herb.); Lancaster Co., *Porter* (Gray Herb.); swamp at Smithville

near Lancaster, in soft mud, half immersed, 1 October, 1866, *Porter* (Mo. Bot. Gard. Herb.); in small ditches, not near tide-water, near Darby, Philadelphia, 4 July, 1866, *Hunt* (Mo. Bot. Gard. Herb.); Delaware Water Gap, June–July, 1870, *Knipe* (Mo. Bot. Gard. Herb.); mountain swamp, 2 miles southwest of Cornwall, Lebanon Co., 1 August, 1878, *Porter* (Mo. Bot. Gard. Herb.); wholly immersed in a lake at Delaware Water Gap, August, 1880, *Canby* (Mo. Bot. Gard. Herb.); Delaware River, at Monroe, Buck Co., 24 July, 1886, *J. A. & H. F. Ruth* (Univ. Minn. Herb.); Monroe Co., 26 July, 1886, *Porter* (Dudley Herb.); McCall's Ferry, 2 miles south of Bethesda, July, 1898, *Galen* (Mo. Bot. Gard. Herb.); Susquehanna River, Wayne Co., 20 July, 1900, *Clute* (Mo. Bot. Gard. Herb.); pool among rocks, York Co., 2–6 July, 1904, *Britton* (Mo. Bot. Gard. Herb. and N. Y. Bot. Gard. Herb.); Sayre, edge of river, August, *Barbour* (Mo. Bot. Gard. Herb.); Delaware Water Gap, 3 July, 1887, *Britton* (Gray Herb.); vicinity of McCall's Ferry, York Co., 5–7 July, 1904, *Rose & Painter 8168, 8216* (U. S. Nat. Herb.); in soft mud of a partially exsiccated pond, near Warriorsmark, Huntingdon Co., at foot of Alleghenies, 20 August, 1868, *Porter* (Mo. Bot. Gard. Herb. and Gray Herb.); in clay mud and water of a pond in the barrens of Huntingdon Co., 1200 ft. above sea-level, September, 1870, *Porter* (Mo. Bot. Gard. Herb. and Gray Herb.); Smithville, Lancaster Co., August, 1865, *Porter* (Mo. Bot. Gard. Herb.); same, 1 October, 1866, (Mo. Bot. Gard. Herb.); pond near Warriorsmark, October, 1870, *Davis* (Mo. Bot. Gard. Herb.).

Delaware: Wilmington, 1860, *Tatnall* (Gray Herb.); in a bog near Wilmington, 1858, *Tatnall* (Gray Herb.); Wilmington, 16 June & 23 July, 1866, *Canby* (Mo. Bot. Gard. Herb. and Gray Herb.); in a ditch near Ogletown (dry at time of collection), 4 August, 1866, *Commons* (Mo. Bot. Gard. Herb.); ponds, Townsend, 4 July, 1896, *Canby* (Mo. Bot. Gard. Herb.); in small ditch along Baltimore River, ⅛ mile below Stanton Station south of Wilmington, 21 September, 1866, *Canby* (Mo. Bot. Gard. Herb.); same, August, 1867, (Mo. Bot. Gard. Herb.); Wilmington, 1865, *Durand* (Mo. Bot. Gard. Herb.); Wilmington, 25 September, 1866, *Canby* (Mo. Bot. Gard. Herb. and Gray Herb.); Wilmington, ditch-

es near Baltimore R. R., 16 June, 1866, *Canby* (Mo. Bot. Gard. Herb.); Wilmington, 23 July, 1866, *Canby* (Mo. Bot. Gard. Herb.); same, 21 September, 1866, & 12 June, 1867, *Canby* (Mo. Bot. Gard. Herb. and Gray Herb.); Wilmington, 2 October, 1866, *Canby* (Gray Herb.); ditches near Stanton, August, 1867, *Canby* (Mo. Bot. Gard. Herb.); Delaware, June, 1872, *Canby* (Gray Herb.); Stanton, June, 1872, *Canby* (Gray Herb.); near Wilmington, *Canby 1957* (Mo. Bot. Gard. Herb.).

Maryland: near Great Falls of the Potomac, 11 June, 1882, *Ward* (Mo. Bot. Gard. Herb.).

Virginia: head of Mountain Lake, Salt Pond Mt., alt. 4000 ft., August, 1889, *Canby* (Mo. Bot. Gard. Herb.); swampy soil near Mountain Lake, Salt Pond Mt., August, 1869, *Canby* (Gray Herb.).

North Carolina: in standing water, Swain Co., 10 August, 1891, *Beardslee & Kofoid* (Mo. Bot. Gard. Herb. and Gray Herb.); near Hendersonville, May, 1919, *Thomas* (Mo. Bot. Gard. Herb.); in bogs formed by cold springs on Spring Mts. (near Columbus), Polk Co., elev. about 3000 ft., 5 May, 1897, *Biltmore Herb. 55641* (Gray Herb.).

South Carolina: springy places near Graniteville, Aiken Co., 19 May, 1899, *Eggert* (Mo. Bot. Gard. Herb.); same station, 24 & 25 May, *Eggert* (Mo. Bot. Gard. Herb.).

Georgia: mountains of Georgia, 1872, *Chapman* (N. Y. Bot. Gard. Herb.); mountain streams of Georgia, 1873, *Chapman* (Mo. Bot. Gard. Herb.); Floy Co., *Chapman* (Mo. Bot. Gard. Herb.); wet shady woods at eastern base of Taylor's Ridge, Whitfield Co., 26 July, 1900, *Harper 310* (Mo. Bot. Gard. Herb., N. Y. Bot. Gard. Herb., and Gray Herb.).

Indiana: in a small pond, 8.7 miles southeast of Paoli, on Paoli and New Albany Pike, 16 October, 1917, *Deam 24360* (Mo. Bot. Gard. Herb.); in small pond on north side of road and about 1 mi. east of Pilot Knob, Crawford Co., 12 October, 1916, *Deam 22385* (Gray Herb.); low place in woods, where in wet seasons the water would course through woods, 4 mi. south and 1 mi. east of Palmyra, Harrison Co., *Deam 20467* (Gray Herb.).

Illinois: Ponds, St. Clair Co., *Eggert* (Mo. Bot. Gard. Herb.).

Missouri: ponds in the Meramec Hills, southwest of St. Louis (Gravois Settlement), September, 1842, *Engelmann* (Mo. Bot. Gard. Herb. and Gray Herb.), TYPE; St. Louis, September, 1842, *Engelmann* (U. S. Nat. Herb.).

58a. Var. **caroliniana** Eaton, Fern Bull. 8: 60. 1900.

Corm 2-lobed; leaves 15–25(30), up to 22 cm. long, little finer than *I. Engelmanni* (much like *I. Dodgei*); peripheral strands 4, weak; stomata numerous; sporangium 6–8 mm. long, 1/3–2/3 covered by velum; megaspores 400–530 μ in diameter, with high reticulate ridges, much crisped and cut with an irregular margin, producing somewhat spiny effect; microspores 24–34 μ long, spinulose.

Distribution: North Carolina, Georgia.

Specimens examined:

North Carolina: Big Rock Creek, Mitchell Co., 1893, *Ashe 1092* (Mo. Bot. Gard. Herb.), TYPE; growing partly immersed, Wetherby's near Salisbury, Mitchell Co., *Ashe 812* (Mo. Bot. Gard. Herb.); Roandale Farm, 28 July, 1900, *Wetherby* (Mo. Bot. Gard. Herb.); edge of fish-pond, gravelly bottom, half submerged or less, Wetherby's, 15 August, 1898, *Wetherby* (Mo. Bot. Gard. Herb.).

Georgia: muddy swamp of Turkey Creek, about 6 mi. south of Dublin, Laurens Co., 21 April, 1904, *Harper 2142* (U. S. Nat. Herb.); in sluggish pine-barren stream, Sumter Co., partly emersed, 24 July, 1901, *Harper 1112* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.).

59. **I. azorica** Dur. Milde, Fil. Eur. 278. 1867; Baker, Jour. Bot. 18: 67. 1880, and Fern Allies, 125. 1887; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 365. *pl. 8. fig. 9, 10, 11.* 1883; Trelease, Mo. Bot. Gard. Ann. Rept. 8: 176 . 1897.

Calamaria azorica Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 2-lobed; leaves 7–25, 8–30 cm. long, slender, flexuous, with narrow basal membranaceous margin; stomata present, but not numerous; peripheral strands none; ligule long subulate; sporangia oval, 4–6 mm. long, 1/3–1/2 covered by velum; megaspores 360–490 μ in diameter, white, reticulate with narrow low distinct crests, mostly rounded, seldom sharp; microspores

brown, 26–37 μ in length, chiefly spinulose, sometimes smoothish.

Distribution: Islands of Azores.

Specimens examined:

Azores: Lago Raza, 4 August, 1894, *Trelease 1262* (Mo. Bot. Gard. Herb.); Corvo Caldeiro, 15 July, 1894, *Trelease 1261* (Mo. Bot. Gard. Herb. and U. S. Nat. Herb.); Flores I., Caldeiro da Lomba, 25 July, 1894, *Trelease 1263* (Gray Herb., Mo. Bot. Gard. Herb. and U. S. Nat. Herb.).

60. **I. japonica** A. Br. Verh. Bot. Ver. Brandenb. 4: 329. 1862, and Monatsber. K. Akad. Wiss. Berlin 1: 459. 1861; Motel. & Vendr. Actes Soc. Linn. Bord. 36: 360. *pl. 11. fig. 10-12.* 1883; Baker, Jour. Bot. 18: 109. 1880, and Fern Allies, 133. 1887; Miquel, Prol. Fl. Jap. 390. 1866-67; Franchet & Sav. Enum. Pl. Jap. 2: 201. 1879.

Calamaria japonica Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

I. edulis Lieb. ex Miq. Prol. Fl. Jap. 390. 1866-67.

Corm 3-lobed; leaves 35–66, 33–52 cm. long, medium coarse, flexuous, gradually tapering to apex, with membranaceous margin conspicuous only at sporangium level; peripheral strands usually 6, 4 of which are stronger; stomata rare; ligule elongated triangular; sporangia 7–9 mm. long, lacking velum, but marked with brown sclerenchyma patches; megaspores white, 560–660 μ in diameter, with large foveolate markings, slightly less regular on apical faces, with well-rounded ridges on basal; microspores pale, 29–35 μ long, smooth.

Distribution: Japan, Yokohama.

Specimens examined:

Japan: Wada-mura, Musashi, 6 September, 1893 (U. S. Nat. Herb.); Tokyo, May, 1888, *collector unknown, 519* (U. S. Nat. Herb.); 30 July, 1890, *Watanabe* (Gray Herb.).

61. **I. Wormaldii** Sim, Trans. S. Afr. Phil. Soc. 16^3: 299. *pl. 5.* 1906, and Ferns of S. Afr. 340. 1915.

Corm 3-lobed; leaves 50–70 in number, terete or somewhat flattened, 22–45 cm. long, stout, hardly narrowed to the rounded point, flaccid, with wide basal sheath briefly extended (2–3 cm.); peripheral strands none; stomata present though not numerous; sporangium large, 5–10 mm. long, 3–3.5 mm. wide, lacking a velum; megaspores 460–640 μ in diameter, with surface decidedly reticulate with prominent rounded ridges on lower

surface, sometimes little sharper above; microspores 28–35 μ in length, tuberculate.

Distribution: East London, S. Africa.

Specimens examined:

South Africa: East London, Lake Province, Union of S. Africa, November, 1921, *Schonland* (Mo. Bot. Gard. Herb.).

In the description published by Sim, mention is made of peripheral strands as being "one marginal on each side throughout." The material at hand in the single collection examined did not show peripheral strands in any sections cut. In all the leaves the basal portion was the chief region available, though some of the narrower part was cut in a few sections. It may be that with exposure near the water surface there is some development of supporting tissue not witnessed in Schonland's collection.

62. I. Duriaei Bory, Compt. Rend. Acad. Paris 18: 1166. 1844.

I. tridentata Dur. acc. Kuhn, Fil. Afr. 195. 1867.

I. ligustica de Not. acc. Kuhn, Fil. Afr. 195. 1867.

Isoetella Duriaei Genn. Comment. Critt. Ital. (1) no. 2: 115. 1861.

Calamaria Duriaei Kuntze, Rev. Gen. Pl. 2: 828. 1891-93.

Corm 3-lobed; leaves 15–35, 8–12 cm. long, rarely longer, slender, firm, recurved, with short wide membranaceous margins at base; bases of leaves persistent, scaly, shining black, with 3 teeth; stomata numerous; peripheral strands 4; sporangia oval, 4–6 mm. long, with complete velum; megaspores white, 600–830 μ in diameter, with prominent commissural ridges, and faces with reticulate markings produced by even, rounded elevations; microspores 26–38 μ in length, tuberculate.

Distribution: Algeria, Corsica, France, Italy, Turkey.

Specimens examined:

Algeria: Algeria, 1841, *Durieu* (Mo. Bot. Gard. Herb.); Bebazoun near Algiers, March, 1844, *Durieu* (Mo. Bot. Gard. Herb.); dry sandy plateaus of Mastapha near Algiers, 7 June, 1863, *Durieu* (Mo. Bot. Gard. Herb.).

Sicily: Pantelleria, Favare, April, 1890, *Rose* (N. Y. Bot. Gard. Herb.); in wet fields, Messina, June, 1907, *Ross 800* (Gray Herb.).

Corsica: pastures, Bastia, 15 March, 1865, *Debeaux* (Mo. Bot. Gard. Herb.); in swampy places, near Bastia, Corsica,

March, 1869, *Gandoger* (Mo. Bot. Gard. Herb.); wet grasslands at edge of water, at "Griggione," near Bastia, 25 April, 1869, *Fl. Exsicc. Billot 2290* (Mo. Bot. Gard. Herb.); Erisa, March, 1885, *Reverchon* (Mo. Bot. Gard. Herb.).

France: Plateau de Roquehaute (Hérault), 3–5 June, 1862, *Durieu* (Gray Herb.); Roquehaute near Béziers (Hérault), 3 June, 1862, *Cosson* (Mo. Bot. Gard. Herb. and Gray Herb.); Roquehaute near Béziers, 5 May, 1866, *Herb. Grand Marais* (Mo. Bot. Gard. Herb.); Portiragnes (Hérault), 30 March, 1890, *Neyraut* (Mo. Bot. Gard. Herb.); Hérault, 1870 (?), *Durieu* (Gray Herb.); sandy clearings of pine between Cannes and Antibes, 1861, *Bourgeau, Pl. Alpes maritimes, (Gay) 361* (Gray Herb.); near Cannes, 13 June, 1861, *Bourgeau 2* (Gray Herb.); "bois de la Moure prés Montpellier", 8 May, 1870, *Duval-Jouve* (Gray Herb.); Antibes, November, 1863, *Kay* (Gray Herb.); wet sandy stretches under the pines, Golfe Jouan, near Antibes, *Shuttleworth* (Gray Herb.).

Italy: Asciano, Prov. Pisa, Tuscany, alt. 12 m., calcareous soil, 14 April, 1906, *Barsali 401* (Gray Herb.); province Pisa, April, 1862, *Ball* (Gray Herb.).

Turkey: Rizeh, Lazistan, arid land at base of Falaises, 10 June, 1866, *Balansa 1560* (Gray Herb.).

Sardinia: St. Barbara near Cagliari, 19 May, 1863, *Ascherson & Reinhardt* (Gray Herb.).

LITTLE-KNOWN FORMS

63. **I. natalensis** Baker, Handbook Fern Allies, 132. 1887. Sim, Ferns S. Afr. 340. 1915.

"Rootstock 3-lobed; leaves 12–16, very slender (¼ lin. diam.), pale green, opaque, firm in texture, 2–3 inches long, rounded on the back, channeled down the face, furnished with stomata and accessory bast-bundles. Sporange small, globose, brownish; *veil none*. Macrospores white, with small tubercles between the ribs and large ones over the remainder of the surface. Microspores granulated."

Distribution: "Natal; Griffin's Hill, Eastcourt, Rehmann. 7296."

Specimens examined:

Africa: Cape of Good Hope, *Lehman* (Gray Herb. and Mo. Bot. Gard. Herb.).

Gray Herb. collections shows megaspores 570–600 μ in diameter, minutely roughened on the three upper faces, and on the fourth, showing short serpentine ridges. The vegetative characters coincide well with Baker's form; the number of leaves is 11, they are fine and long (31–32 cm.), and bear oblong sporangia (3–5 mm. long), with *no* velum.

It seems as if Rehmann might conceivably be a misprint of Lehman.

Mo. Bot. Gard. Herb. specimen has 10 very slender leaves, 30–35 cm. long, with fairly prominent basal sheath; spores of same character as above but as low as 480 μ; velum very narrow.

64. **I. neoguineensis** Baker in Sadebeck, Engl. and Prantl, Nat. Pflanzenfam. 1[4]: 776. 1901.

Placed with *I. Mulleri* A. Br. and *I. Kirkii* A. Br., under division with indusium complete, with more or less numerous stomata; megaspores gray or light gray, warty.

List of Exsiccatae Cited

The distribution numbers are printed in italic. Collections distributed without numbers are indicated by a dash. The numbers in parentheses indicate the species numbers in the present revision.

Allard — (51).
Allen — (42); — (50); — (55).
Anderssen — (40).
Andrews — (48a).
Archer — (23).
Areschoug — (51).
Arrhenius — (40).
Arthur, Bailey, Holway *B413, B87* (42).
Arsene *3653* (37).
Ashe *1092, 812,* — (58a).
Ascherson — (7); — (16); — (51); — (62).
Ascherson & Reinhardt — (16); — (25a); — (62).
Austin *3* (58).
Balansa *1560* (62); *1327* (25a); *849* (25); — (10).
Balfour — (51).
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Ballard — (6).
Barber *394* (42).
Barbour — (58).
Bardell — (50).
Barsali *401* (62).
Battey — (42).
Beardslee & Kofoid — (58).
Bergesen — (51).
Bessey *1* (52); *2* (35).
Best — (48a).
Best & Crawford — (48a).
Billot — (51); *2290* (62).
Biltmore Herb. *4264, 4264b* (29); *55641* (58).
Bishop — (42); — (58); — (42a).

Bissell — (42); — (55); — (58); — (42a); — (48).
Blanchard — (42).
Blankinship — (58).
Blasdale — (26).
Blewitt — (58).
Blomberg — (40).
Blytt *1951* (40); *1958* (51).
Bolander — , *5093, 5091, 5080* (35); *6025, 6383* (35a).
Boldt *17, 418* (51).
Boott — (42); — ,*11* (54); — (55); — (58).
Boreau — (12).
Bory —(25); — (10); — (15a).
Bourlier — (15).
Bourgeau — *2, 361* (62).
Bragg — (55).
Brainerd — (42).
Brand — (51).
Brandegee — (26); — (34); *674* (34a); — (27); — , *2001* (35).
Braun — (40); — (51).
Bristol — (42).
Britton, Dr. & Mrs. — (42).
Britton — (42); — (46); — (54); — (58).
Brown — (42).
Bubani — (6).
Buchenau — (51).
Buchheister — (58).
Budden — (51).
Burbank, Grout & Eggleston — (42).
Burtt Davy — (27).
Bush — ,*441, 746, 267, 35, 107, 1531,* (38); *1530, 107, 231, 68, 7547, 2917, 4511* (39).
Butler — (38); — ,*24* (39).
Butter — (51).
Canby — (29); *136* (39); — (42); — (47); — (48); *1957,* — (58).
Carnel — (25).
Celakovsky *1503* (51).
Cesati — (7); — (40).
Chaboisseau *395, 70* (12).
Chamberlain — (42).
Chapman — (31); — (42); — (58).
Chase *86, 136* (38).
Cheeseman — ,*56* (17); — (18).
Cheveneau — (6).
Chickering *7* (48).
Chiovenda — (40).
Christ — (40); — (51).
Churchill — (42); — (55); — (58).
Clauson *99, 99bis* (15).
Clemens *1, 2* (35).
Clements, R. E. & E. S. *493.1* (42).
Clinton — (42).
Clokey *3986* (35).
Clute — (42); — (58).
Collins — (42).
Commons — (48); — (58); — (47).
Congdon *91* (34); *991* (35).
Cooper *26* (54).
Copeland *2231* (34).
Cosson — (6); — (15); — (15a); — (15b); — (25); — (40); — (51); — (62).
Coville *2483, 1053* (35); *84* (42); *123* (47); *83, 78,* (54); *62* (54a); *2219* (55).
Coville & Funston *1722, 1643, 1650, 1691* (35).
Coville & Kearney *2336, 2337, 386* (43).
Coville & Leiberg *271* (35).
Cowles *776* (42).
Cowles & Harvey *2* (42); — ,*1* (54).
Croall —, *1418* (51).
Curran — (34); — (26); — (27); — (35); — (52).
Curtiss *3813* (31); *3813, 6696* (31a).
Cusick *1451* (35).
Darlington — (42).
Davenport — (42).
Davis — (42); — (58).
Deam *24360, 20467, 22385* (58).
de Bary —(40).
Debeaux — (15); — (15a); — (25); — (62).
de Gerard — (6).
de la Perraudiere — (6).
Delile — (6).
Deloynes — (12).
Dement — (38).
Desmazières *597* (51).
de Vichet — (6).
Dodge — (42); — (46); — (55); — (58).
Doms — (12); — (51).
Dorfler *3698* (6).
Dowell *6455* (47).
Drushel *4664* (58).
Dudley *1043* (34); — (58).
Duggar — (58).
Durand — (48); — (58).
Durieu *21* (6); — (11); — (10); — (15a); — (25); *781* (25a); — (40); — (51); — (62).
Duseu — (40).
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Dutton *397, 198, 260* (42); *232* (48); *787* (54).
Duval-Jouve — (62); — (6).
Eames *9671* (42a); — (48); *5294* (48a); — (58).
Eames & Godfrey *9604* (55); *8223, 9204a* (58).
Eames, Metcalf & Wiegand *5445* (42).
Eastwood — (34); — (26).
Eaton, *ex herb. E.* (29); *337, 1244, 1455, 832* (31a); *ex herb. E.* (11);

441, 187, 699, 431, 425a, 482b, 483a, 364, 239, 197, 380, 192, 919, 377, 441, 913 (42); *351,163, 589, 898, 482c, 427, 217, 919* (46); — (48); *351, 362, 900, 942* (48a); *440, 482C, 483B, 424, 431, 960, 197, 382, 378, 376* (55); *482A, 299, 432* (56); *439, 363, 364, 231, 1* (58).

Eaton — (48); *1* (58).

Eggert — (29); — (38); — (39); — (58).

Eggleston *3026, 1785, 2201, 2472, 699* (42); *1786* (48); *2200* (55).

Ehlers *621, 817* (54).

Engelmann —, *1954* (29); — (35); — (42); — (52); — (54); — (58).

Engler — (51).

Ennis — (48).

Fabre — (25).

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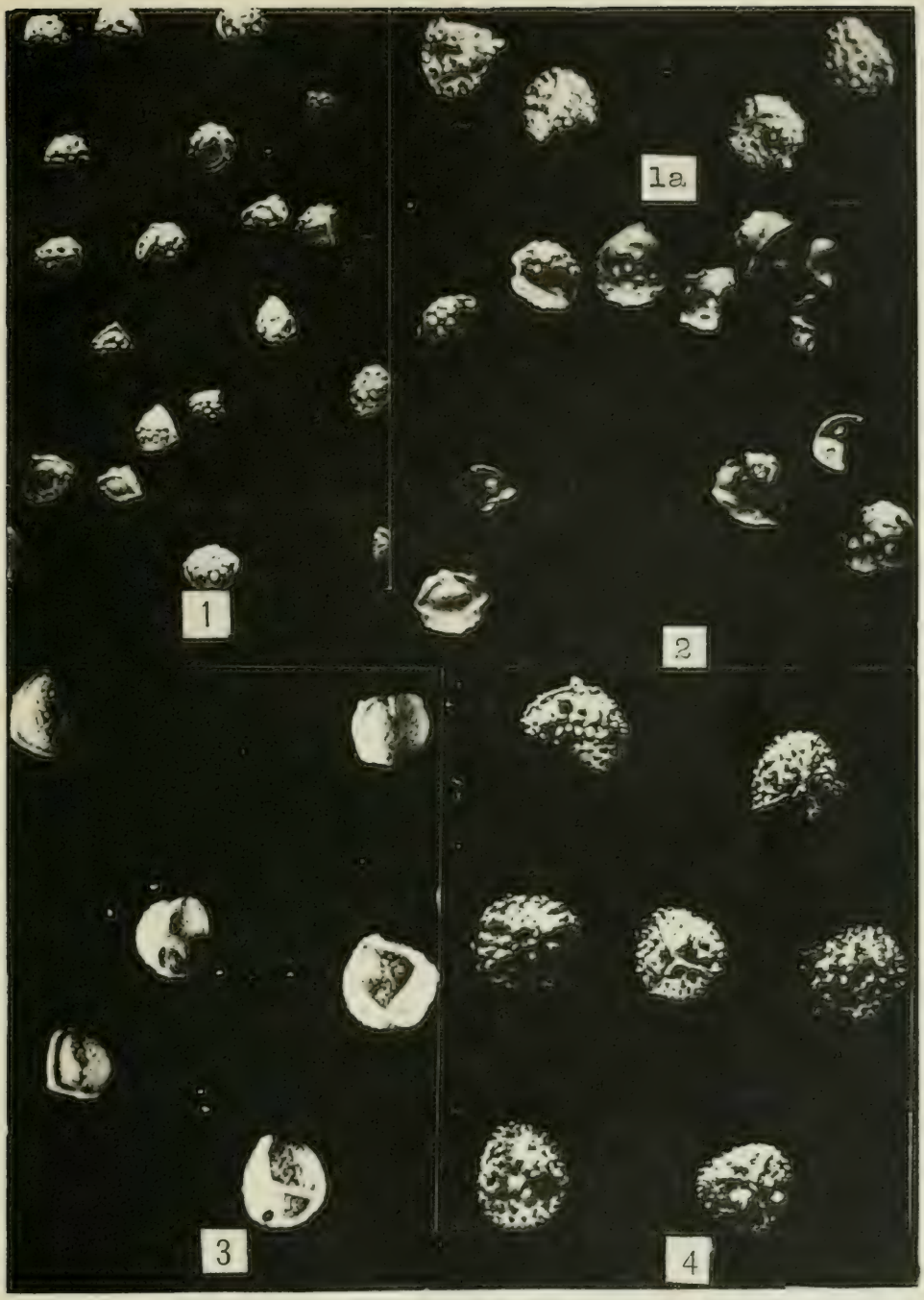
Explanation of Plate

In this and the following plates, which are reproductions of photographs, the magnification is approximately 21 diameters in all cases of megaspores.

PLATE 12

Fig. 1. *Isoetes Schweinfurthii* A. Br. Megaspores.
Fig. 1a. *I. ovata* Pfeiffer. Megaspores.
Fig. 2. *I. coromandelina* L. fil. Megaspores.
Fig. 3. *I. setacea* Bosc. Megaspores.
Fig. 4. *I. Malinverniana* Cesat. & De Not. Megaspores.

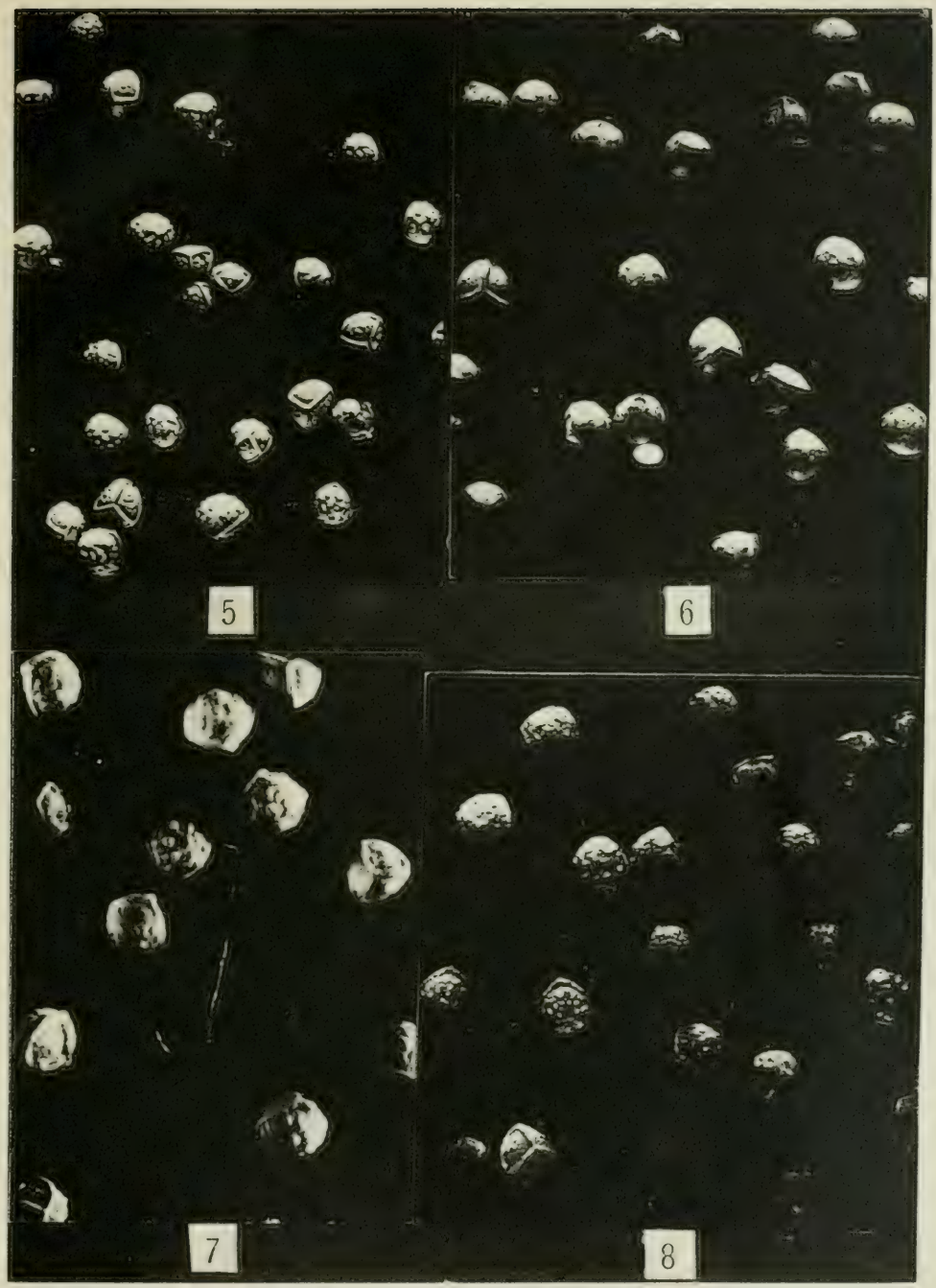


PFEIFFER—MONOGRAPH OF ISOETACEAE

Explanation of Plate

PLATE 13

Fig. 5. *Isoetes cubana* Engelm. Megaspores.
Fig. 6. *I. adspersa* A. Br. Megaspores.
Fig. 7. *I. Boryana* Dur. Megaspores.
Fig. 8. *I. tenuissima* Boreau. Megaspores.

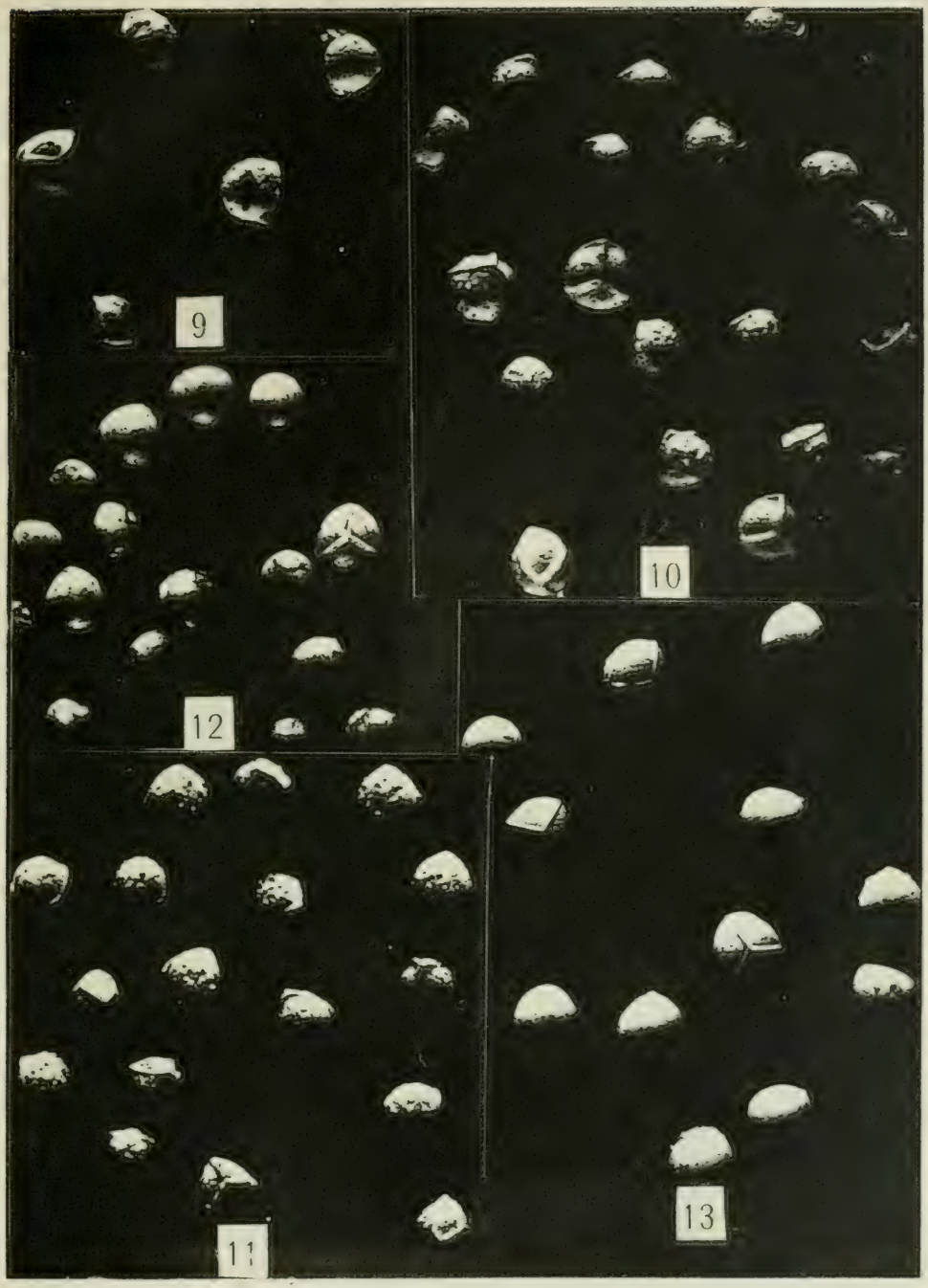


PFEIFFER—MONOGRAPH OF ISOETACEAE

Explanation of Plate

PLATE 14

Fig. 9. *Isoetes velata* var. *Perralderiana* Pfeiffer. Megaspores.
Fig. 10. *I. velata* A. Br. Megaspores.
Fig. 11. *I. tegulensis* Genn. Megaspores.
Fig. 12. *I. alpina* Kirk. Megaspores.
Fig. 13. *I. Kirkii* A. Br. Megaspores.

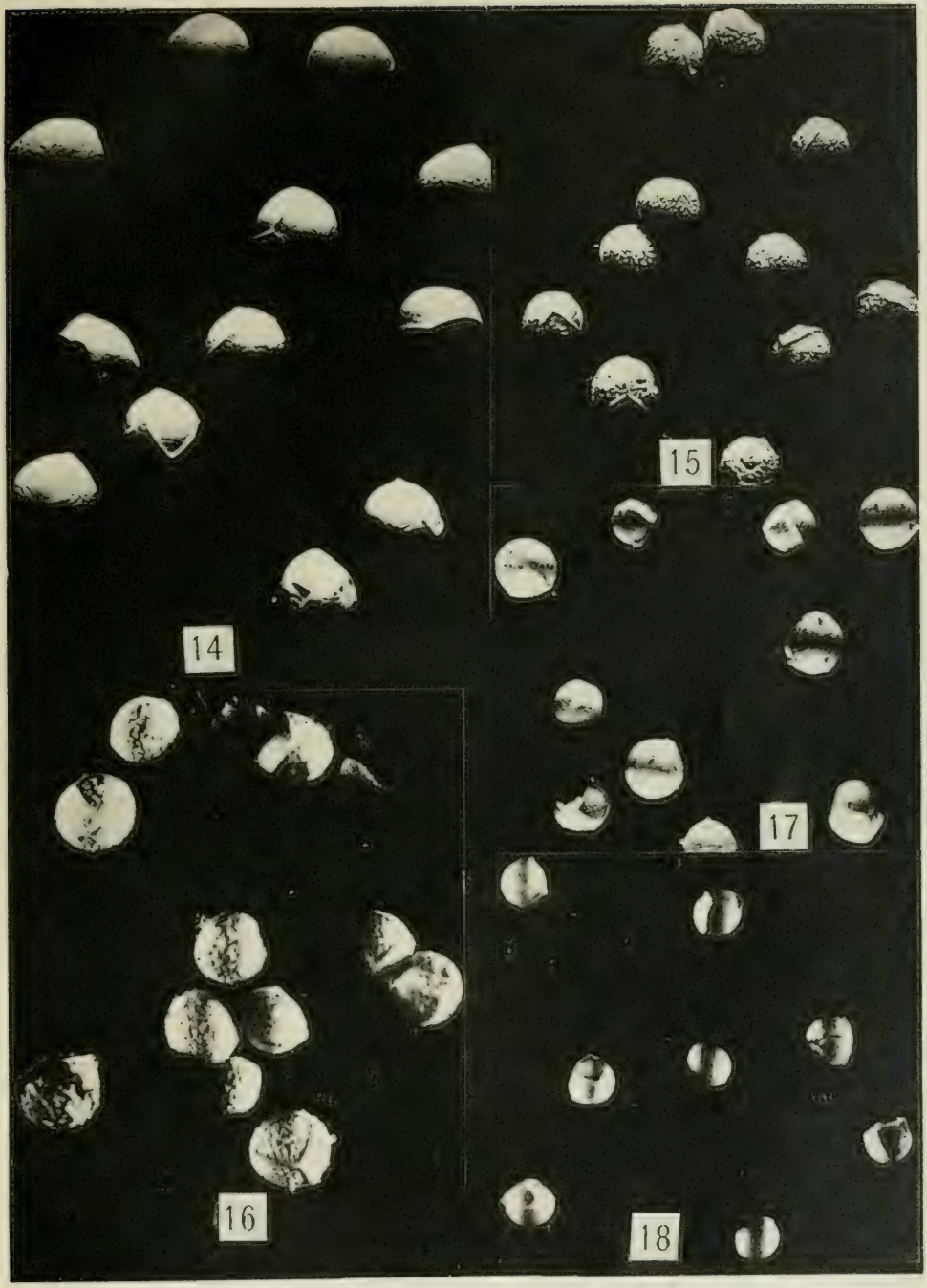


PFEIFFER—MONOGRAPH OF ISOETACEAE

Explanation of Plate

PLATE 15

Fig. 14. *Isoetes Gunnii* A. Br. Megaspores.
Fig. 15. *I. Drummondii* A. Br. Megaspores.
Fig. 16. *I. histrix* Bory & Dur. Megaspores.
Fig. 17. *I. Nuttallii* A. Br. Megaspores.
Fig. 18. *I. Orcuttii* Eaton. Megaspores.

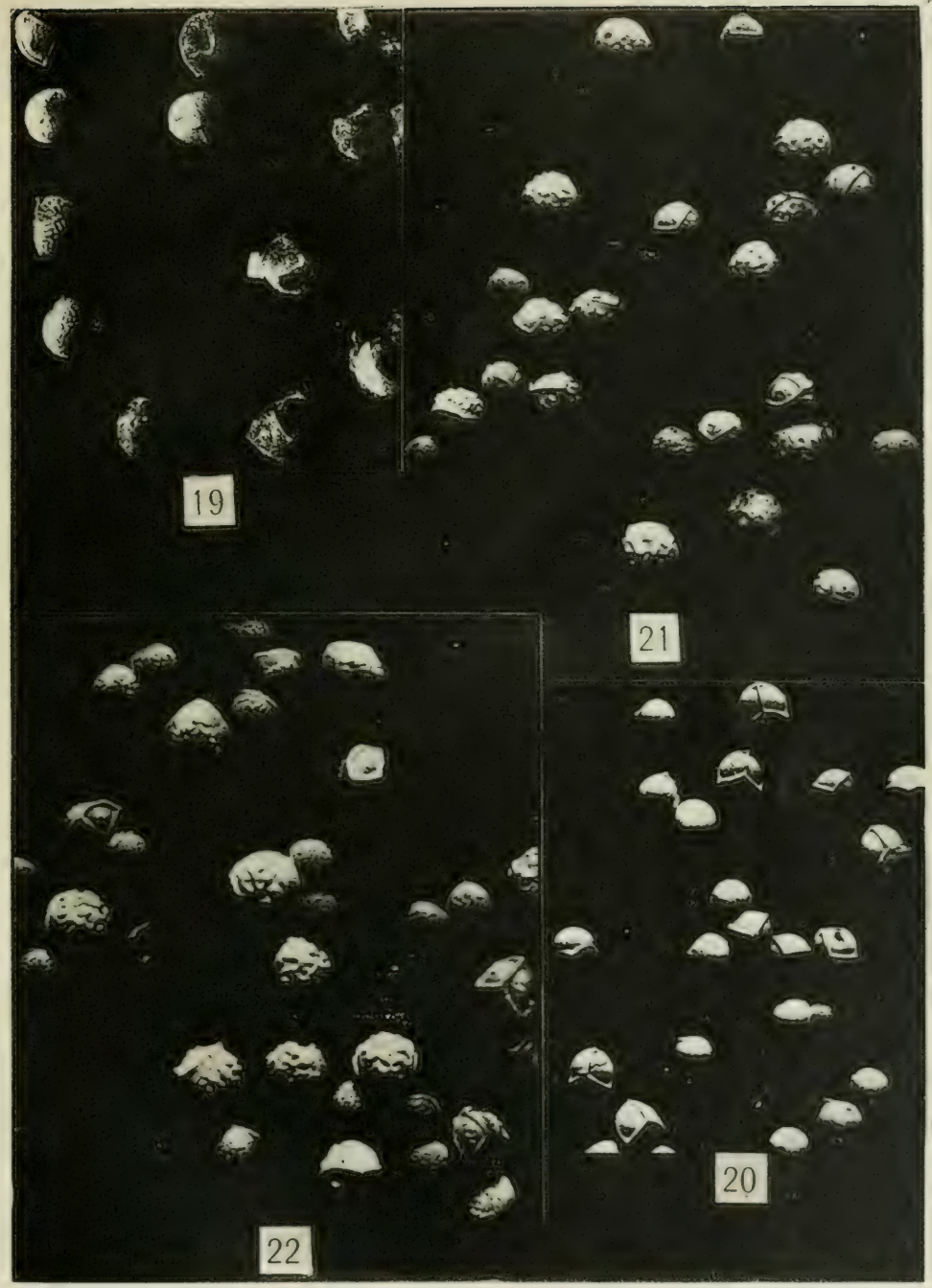


PFEIFFER—MONOGRAPH OF ISOETACEAE

Explanation of Plate

PLATE 16

Fig. 19. *Isoetes melanospora* Engelm. Megaspores.
Fig. 20. *I. lithophila* Pfeiffer. Megaspores.
Fig. 21. *I. flaccida* Shuttlew. Megaspores.
Fig. 22. *I. flaccida* var. *alata* (Small) Pfeiffer. Megaspores.



PFEIFFER—MONOGRAPH OF ISOETACEAE

Explanation of Plate

PLATE 17

Fig. 23. *Isoetes Howellii* Engelm. Megaspores.
Fig. 24. *I. Bolanderi* Engelm. Megaspores.
Fig. 25. *I. Tuerckheimii* Brause. Megaspores.
Fig. 26. *I. mexicana* Underw. Megaspores.
Fig. 27. *I. melanopoda* Gay & Dur. Megaspores.
Fig. 28. *I Butleri* Engelm. Megaspores.

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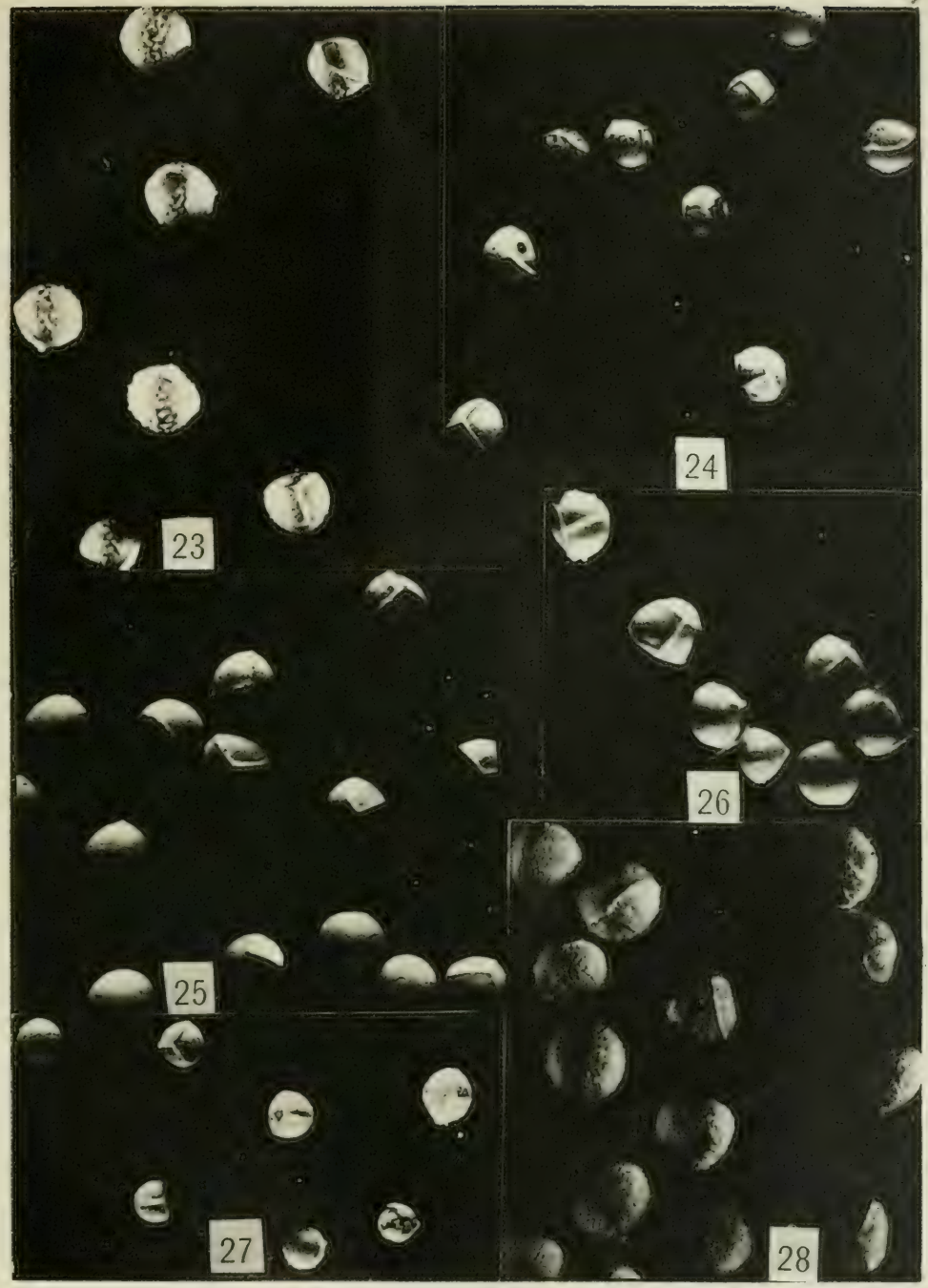
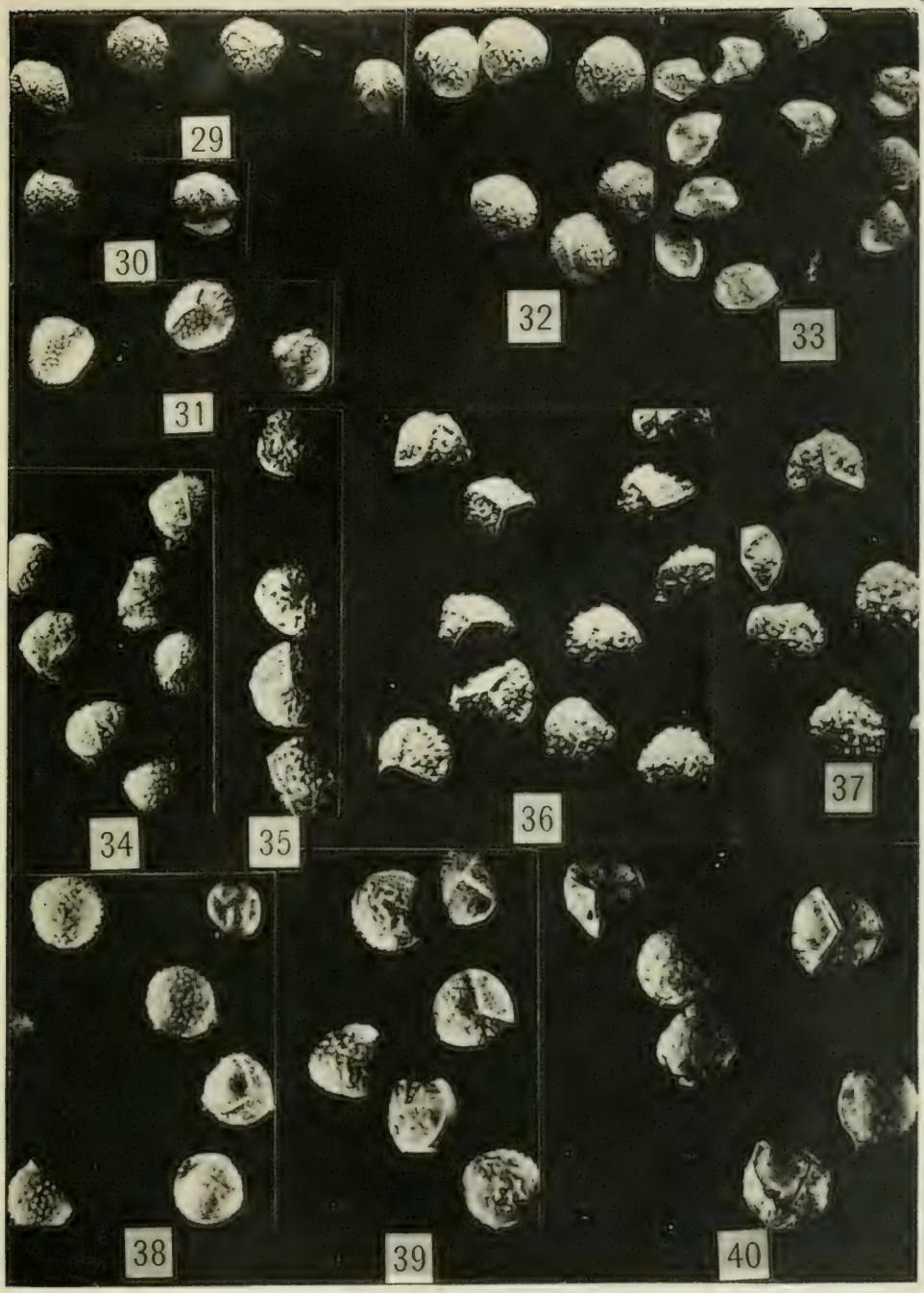


PFEIFFER—MONOGRAPH OF ISOETACEAE

Explanation of Plate

PLATE 18

Fig. 29. *Isoetes echinospora* Dur. Megaspores.
Fig. 30. *I. Brochoni* Motel. & Vendr. Megaspores.
Fig. 31. *I. Braunii* Dur. Megaspores.
Fig. 32. *I. truncata* Clute. Megaspores.
Fig. 33. *I. Eatoni* Dodge. Megaspores.
Fig. 34. *I. saccharata* Engelm. Megaspores.
Fig. 35. *I. riparia* Engelm. Megaspores.
Fig. 36. *I. riparia* var. *canadensis* Engelm. Megaspores.
Fig. 37. *I. Pringlei* Underw. Megaspores.
Fig. 38. *I. Flettii* (Eaton) Pfeiffer. Megaspores.
Fig. 39. *I. lacustris* L. Megaspores.
Fig. 40. *I. occidentalis* Hend. Megaspores.



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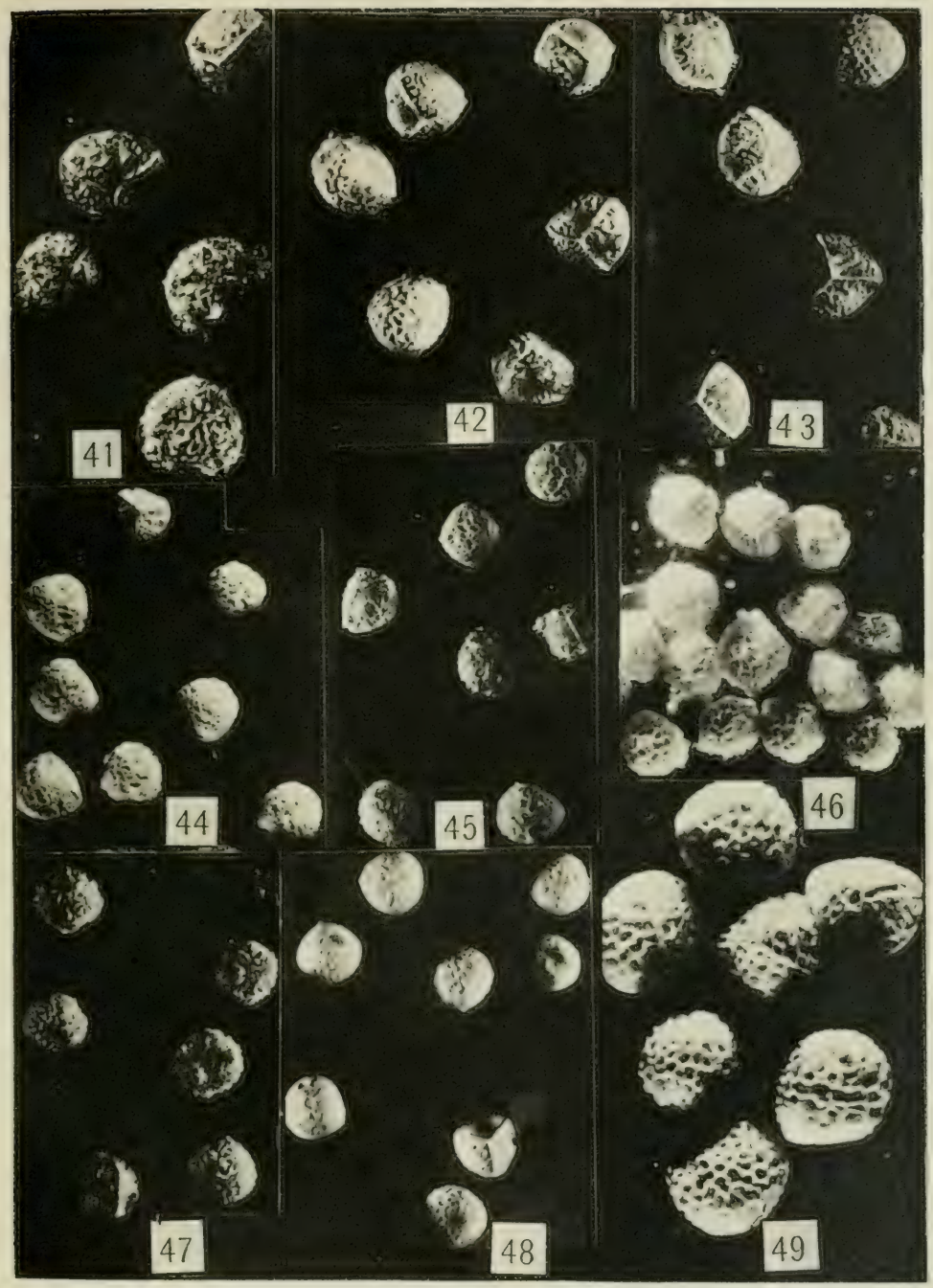
Explanation of Plate

PLATE 19

Fig. 41. *Isoetes macrospora* Dur. Megaspores.
Fig. 42. *I. macrospora* f. *hieroglyphica* (Eaton) Pfeiffer. Megaspores.
Fig. 43. *I. Tuckermani* A. Br. Megaspores.
Fig. 44. *I. foveolata* Eaton. Megaspores.
Fig. 45. *I. Engelmanni* A. Br. Megaspores.
Fig. 46. *I. Engelmanni* A. Br. Megaspores with dust-like microspores in the background, showing relative size.
Fig. 47. *I. Engelmanni* var. *caroliniana* Eaton. Megaspores.
Fig. 48. *I. azorica* Dur. Megaspores.
Fig. 49. *I. Duriaei* Bory. Megaspores.



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